The Impact of Multimorbidity on Diabetes Care Quality for Adults with Diabetes

By

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ABSTRACT

Background: Multimorbidity affects 26 million persons with diabetes in the US. Current diabetes care is suboptimal, leading to microvascular and macrovascular complications including death. Current guidelines and interventions are insufficient to support patients and providers in integrating care needs in diabetes and multimorbidity. These studies examine the impact of chronic conditions on diabetes care to provide a basis for interventions to improve diabetes care for patient with multimorbidity.

Methods: First, a comprehensive set of 62 chronic conditions were categorized by primary care experts as either concordant or discordant with diabetes care. Next, the impact on diabetes care of the number of concordant and discordant conditions was assessed for 24,430 patients with diabetes and 6 diabetes quality metrics. Finally, the impact of 62 individual conditions on diabetes care was assessed for the same 24,430 patients.

Results: Twelve conditions were found to be concordant and 50 discordant with diabetes. Diabetes care was better for several outcomes with a higher number of concordant conditions. The number of discordant conditions had a more limited impact. Many individual conditions were related to suboptimal diabetes care, including several conditions that were considered concordant with diabetes. A third of conditions had no relationship with diabetes care.

Conclusions: The impact of chronic conditions on diabetes care is determined in part, but not entirely, by the concordance and discordance of chronic conditions with diabetes. Diabetes care improvement interventions should integrate care needs of diabetes and multimorbidity, and target patients at risk of suboptimal care due to their multimorbidity profiles.

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Completing a dissertation might be equated to completing a marathon. It starts with an idea, the dream and desire to run a marathon. It is completed through choosing training over other activities, and rest over more training, and through coaches, family, friends and near strangers providing support and advice. While the flash of running a marathon comes with the sprint at the end and the finisher's medal, the race is completed one step at a time, pushing over 26.2 miles, building on months and years of putting one foot in front of the other. It seems huge looking forward to it, and huge looking back, but when you are in it, it is just one foot in front of the other until you finish.

My dissertation began as an idea, a dream, to earn a PhD. The dream stayed with me, and after residency, I took the leap. With the support and guidance of those far wiser and more knowledgeable, I began my race to a PhD one step at a time. I started with training, as prescribed in my Graduate Student Handbook and by my advisors. After 2 years of training, the race was off. Day by day I worked on my dissertation, pushing through each step. Some days were harder than others, some days were easier. Some were certainly more productive than others! There were hard spots, walls and aid stations, cheering sections and more than one second wind. Now that I have come to the finish line, breathless and excited, I cannot believe what I accomplished, one step at a time. I wish to thank those who guided me, helped me and supported me through this process, giving time, energy and expertise. This dissertation is yours too.

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IRB and Protection of Humans Subjects

The research for Paper 1 was determined to be exempt under the survey exemption category January 2013 by the Minimal Risk Institutional Review Board at the University of Wisconsin School of Medicine and Public Health. Access to primary care providers for Aim 1 was approved by the Departments of Family Medicine (DFM) Research Committee and The Department of Internal Medicine –General Internal Medicine Division, Research Section, at the University of Wisconsin School of Medicine and Public Health. The research for Papers 2 and 3 was determined to be exempt from IRB oversight on March 25, 2013 by The Minimal Risk Institutional Review Board at the University of Wisconsin School of Medicine and Public Health.

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CHAPTER 1. INTRODUCTION AND SPECIFIC AIMS

For the 21 million individuals in the US with multimorbidity and diabetes, health care is complex, costly and leads to suboptimal outcomes, and there are no evidence-based strategies to improve care. Patients with multiple chronic conditions and their clinicians are faced with a daunting list of care needs, with little direction on where to focus their limited resources. At a minimum, this adds demand for time and resources, both for the patient and providers. At worst, treatment for comorbidities may conflict with diabetes care. Current guidelines for chronic condition management, including diabetes, do not support clinicians and patients in integrating and prioritizing care needs in multiple chronic conditions, and conflicting care goals may contribute to poor outcomes. There is an *urgent need* to understand how clinicians and patients should prioritize care of concurrent chronic conditions to achieve optimal outcomes, especially for patients with common, severe conditions such as diabetes. In the absence of such knowledge, the development of targeted interventions and clinical practice guidelines for multimorbidity will not be possible.

My *long-term goal* is to improve care for patients with multiple chronic conditions. The *overall objective* of this investigation is to explain the impact of multimorbidity on diabetes care goal achievement in patient with diabetes and multimorbidity. My *central hypothesis* is that patients with multiple conditions with similar care goals as diabetes are more likely to achieve those diabetes care goals than patients with co-morbid conditions without diabetes-similar care goals. My proposal expands a previous conceptual framework addressing the impact of diabetes concordant and discordant

conditions on diabetes care. In that model, Piette and Kerr hypothesize that concordant conditions have similar management as diabetes and their presence should improve diabetes care because the concordant condition will support completion of diabetes care. Discordant conditions do not share treatment with diabetes. Their care is either not indicated or contraindicated in diabetes, and management of discordant conditions could detract from diabetes care. For example, dyslipidemia would be considered concordant and asthma discordant with diabetes. Past research supports and conflicts with Piette and Kerr's model, and suggests that a more detailed understanding of comorbidity concordance and discordance is necessary to examine the impact of multimorbidity on diabetes care.

Diabetes management involves achieving multiple testing and treatment goals, and comorbid conditions may be concordant with some goals and not others. For example, coronary artery disease might be concordant with the cholesterol control goal but discordant with kidney monitoring. My expanded model uses the overlap in care goals between diabetes and a comorbid chronic condition to determine its concordance or discordance with diabetes. Additionally, I hypothesize that the impact of a chronic condition on diabetes care goal achievement is due to more than the overlap in care goals, and individual conditions will, in some cases, impact care differently than what is expected from their concordance or discordance with diabetes. Other factors, including patient and provider preference for care, clinical dominance and symptoms, likely combine to determine diabetes goal achievement.

The *rationale* for my proposed research is that the first step in integrating the care for multimorbidity is understanding how overlap in care goals influences diabetes care. This will allow the development and future testing of a patient-centered targeted intervention to improve outcomes in patients with multimorbidity that includes diabetes. The primary goal is to explain the role of goal-concordance and goal-discordance in diabetes goal achievement as a first step to inform care prioritization in multimorbidity. This becomes particularly relevant amid rising chronic disease prevalence and primary care redesign efforts to provide patient-centered care at and between visits.

The *specific aims* of the current investigation are:

Aim 1: Determine the perceived concordance and discordance of chronic conditions with specific diabetes care goals based on primary care provider consensus opinion of outpatient chronic condition management.

Aim 2: Identify patients at-risk for suboptimal diabetes care based on the number and mix of concordant and discordant conditions in the patient's multimorbidity profile.

Aim 3: Determine empirically which individual conditions are related to optimal or suboptimal diabetes care goal achievement, and compare to the expected effect based on each condition's perceived concordance or discordance.

Aim 1 will use a Delphi methodology survey with an expert panel of local primary care providers. Aims 2 and 3 will be achieved using two years of data from an existing database of patient-level electronic health records for approximately 24,000 patients with diabetes. The diabetes care goals of interest are testing and treatment goals that are related to long term outcomes in diabetes and that are commonly measured by diabetes quality metrics (HbA1c testing and control, LDL cholesterol testing and control, kidney testing and blood pressure control).

Our *expected outcomes* are as follows. First, I will have determined how primary care providers currently view the overlap in care between diabetes and other chronic conditions. Second, I will have identified patients at-risk for suboptimal diabetes care based on their multimorbidity profile. I will also have tested a new method to describe multimorbidity and its impact on diabetes care. Third, I will have identified which individual chronic conditions are related to optimal and suboptimal diabetes care, allowing for the influence of multiple unmeasured factors beyond condition concordance and discordance.

The results of this study have the potential to dramatically improve our understanding of diabetes and multimorbidity care, leading to future targeted patient-centered interventions and evidence-based care guidelines for this growing, high-risk population.

CHAPTER 2. BACKGROUND AND SIGNIFICANCE OF DIABETES AND MULTIMORBIDITY

2.1. The Burden of Diabetes and Multimorbidity

The most common chronic condition in the US is multimorbidity, the presence of two or more co-occurring chronic conditions, affecting almost 1/3 of the US adult population.[1,2] Diabetes is also extremely common, affecting over 31 million individuals in the US, 9.5% of the population.[2,3] The incidence of diabetes is increasing rapidly and is projected to affect 12% of the US population or 48.3 million individuals by 2050; further, 1 in 3 individuals born in 2000 is expected to develop diabetes in their lifetime.[4] The prevalence of other chronic conditions is increasing as well so that individuals are sicker as they live longer,[5] adding to the burden already faced by those with diabetes. Currently, over 26 million individuals with diabetes have multimorbidity[6] as 83% percent of persons with diabetes have at least one other chronic condition and nearly a quarter have 5 or more other conditions.[7] These numbers increase to 95% and 33%, respectively, when considering only Medicare beneficiaries, of whom 28% have diabetes.[8] Multimorbidity is common in both the elderly and the middle-aged, as almost half of those with multimorbidity are under age 60.[9,10]

Patients with diabetes and multimorbidity can, by definition, have any specific co-morbid conditions, however certain conditions co-occur more often. Diabetes in the Medicare population most commonly co-occurs with hyperlipidemia, hypertension, and ischemic heart disease.[8] In the non-elderly VA population diabetes is most common in a triad with

hypertension and hyperlipidemia as well as in triads with ischemic heart disease and either hypertension or hyperlipidemia.[11] Hypertension, one of the most common conditions to co-occur with diabetes, is present in 67% of individuals with diabetes while neuropathy affects up to 70% of individuals with diabetes.[6] Depression is twice as likely in patients with diabetes as in those without diabetes.[6]

Current diabetes quality of care is suboptimal and costly. Half of individuals with diabetes are above goal for blood pressure and LDL cholesterol, and a 1/3 have HgbA1c>9%.[12] Diabetes is the leading cause of new blindness in young and middle aged adults, the leading cause of kidney failure in the US, and a leading cause of heart disease and stroke; the age-matched death rate for persons with diabetes is about twice that as without diabetes.[6] Additionally, diabetes care is expensive, accounting for $192 billion/year in direct and indirect costs,[6] at an individual rate of almost $10,000/person annually, which is 2-5 times higher than without diabetes.[6,13,14]

Adequate control of diabetes, and its comorbidities, has been shown to improve health outcomes. Control of hypertension reduces stroke risk and cardiovascular event risk by up to 50% and microvascular complications by 33%.[6] Likewise, control of hyperlipidemia reduces cardiovascular events 20-50 fold.[6] Treatment of renal dysfunction can prevent progression to failure in 30-70% of cases and management of diabetic eye disease reduces vision loss by 50-60%.[6]

For those with diabetes and multiple chronic conditions, care is complex and health outcomes are worse than for patients with diabetes alone.[15,16] The cumulative 5-year mortality rate in 55-64 year old veterans with diabetes alone is 7.07%, and for those with diabetes, ischemic heart disease, hypertension and COPD, is 22.33%, adjusted to age of the overall cohort.[16] Although some studies have suggested patients with multimorbidity receive better care quality than patients without or with fewer comorbidities, other studies have not. A study on 8 chronic conditions out of the ACOVE (Assessing Care of Vulnerable Elders) project that was adjusted for number of office visits,[17] showed improved care quality with multimorbidity. However, the multimorbid patients with the highest quality achievement in this study still received less than 60% of recommend care,[17] despite the association of care quality with survival in this population.[18] Other studies either did not adjust for office visits or they showed less or no improvement in care quality after adjustment for number of office visits, including a report from the ACOVE study[19] and a study that specifically looked at diabetes outcomes among patients with diabetes,[7] suggesting that better care in multimorbidity might be due to increased opportunities for care. There is an urgent need to improve care for these complex patients as identified by the Diabetes Objectives in Healthy People 2020 and the Department of Health and Human Services 2010 Strategic Framework on Multiple Chronic Conditions.[20,21]

Optimal management of diabetes depends on appropriate management of diabetes amid any co-existing chronic conditions. However, there are no clear guidelines on how best to manage diabetes in the setting of multimorbidity, especially those with diverse

and often conflicting management needs.[22-25] Exactly how specific comorbidities impact care and how patients with multimorbidity including diabetes should be managed is a current knowledge gap. Without an understanding of the interaction of care for diabetes and comorbid conditions, new clinical practice guidelines and patient-centered interventions cannot be developed to optimize diabetes care and the care of multimorbidity more generally.

2.2. Defining and measuring multimorbidity

Management of chronic conditions in a health care setting has for a long time centered on a single chronic condition.[23,26] However, as more individuals have two or more chronic conditions than have a single chronic condition, this is no longer practical.[27] Recent research has focused on defining, quantifying and explaining the effects of multimorbidity.

The terms “multiple chronic conditions”, “comorbidity” and “multimorbidity” are all commonly used in the literature.[21,23,28] “Multiple chronic conditions” is the co-occurrence of two or more chronic conditions.[22,23,29] A “chronic condition” is defined by the Agency for Healthcare Research and Quality (AHRQ) from a medical care approach as a health condition that lasts more than a year and requires medical care and/or limits activities of daily living.[21,30] For example, diabetes, obesity and osteoarthritis are all chronic conditions. A condition is defined as a medical diagnosis or groups of diagnoses that have specific pathophysiologic changes, treatments and/or signs and symptoms. For example, a patient with the medical diagnosis “intermediate coronary syndrome” or

"coronary atherosclerosis not otherwise specified" has plaque inside the blood vessels of the heart, and is said to have the condition "coronary atherosclerosis." The Clinical Classification Software (CCS) defines conditions in this manner and can be to describe the number and type of conditions a patient has clinical practice and in research, including the research in this study. [30,31]

The terms "comorbidity" and "multimorbidity" are both ways to frame multiple chronic conditions within patients. "Comorbidity" is traditionally defined as a condition that occurs with an index condition, a condition of interest to the research or clinician (Figure 2.1).[23] Most research on chronic conditions has been done focusing on an index condition (e.g., diabetes) and its comorbidities (*e.g.,* hypertension and depression). Clinical practice guidelines are written around index conditions.[25,32] Clinically, this model works for specialist care, where a patient is typically seen for a single condition, *i.e.* the index condition .[33]

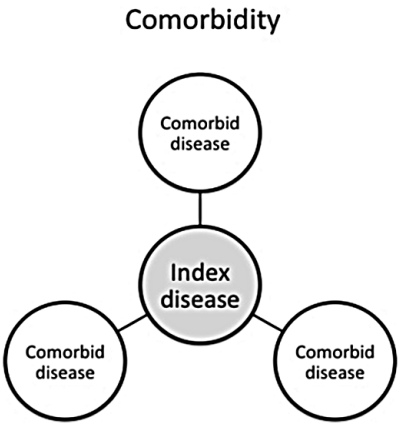

Figure 2.1. Diagram of Comorbidity. Multiple conditions co-occur around one central index condition.[23]

"Multimorbidity," in contrast, centers on the constellation of all chronic conditions within an individual (Figure 2.2). In multimorbidity, all co-occurring diseases are considered together and without a single dominant condition[34] in a patient-centered approach.[35] Although the term "multiple chronic conditions" can be used to refer to an index condition and its co-morbidities, most recent work on multiple chronic conditions takes a multimorbidity approach, and multiple chronic conditions and multimorbidity typically describe the same phenomenon.[21,28]

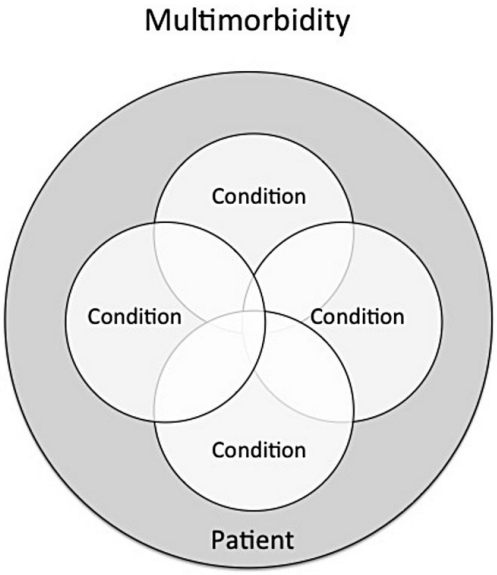

Figure 2.2. Diagram of Multimorbidity. Multiple conditions co-exist within one person.[23]

The concept of multimorbidity is especially relevant in primary care where all conditions might be treated in a single visit.[29,33] As all co-occurring chronic conditions and how they affect the individual are considered in developing a treatment plan, this approach leads to patient-centered, not disease- centered, care.[35,36] Of course, as certain conditions may be clinically or symptomatically dominant[23] some conditions might rightfully have a greater focus in a care plan. The presence of several unrelated conditions in

multimorbidity requires complex decision-making.[35,37,38] Treatment for multimorbidity including diabetes depends on the interaction between these conditions and their management.[35]

2.2.1 The Challenges of Studying Multimorbidity

Quantifying and studying patients with multiple chronic conditions can be complex due to the heterogeneous nature of the population as each patient with multiple chronic conditions can have a different mix of conditions (e.g., arthritis and diabetes in one person versus heart disease, hypertension and asthma in another person).[39] Even when patients are grouped by a certain disease, such as diabetes, measuring their co-morbid conditions in a meaningful way is challenging.[34,40] Much of current research, such as this work, continues to group patients around an index disease as a first step towards understanding the interactions of multiple conditions on health care delivery and outcomes.

A traditional method used to quantify chronic disease burden in individuals with chronic disease is a total count of comorbidity.[26,41] This method provides some understanding of condition burden and can show the health and financial impact of the increasing number of chronic conditions. However, this approach is far from complete as it considers all co-morbidities to be of similar influence on health and treatment, when clearly some chronic conditions are more likely to harm health or require more intensive treatment than others.[42,43] For instance, the type and severity of co-morbid conditions in diabetes

has been shown to affect diabetes self-management.[43] There is a need to move beyond total comorbidity counts to understand how multimorbidity affects diabetes care.

Alternatives to total comorbidity counts have been suggested. Starfield and Kinder suggest that the ACG System (Adjusted Clinical Groups) be used to characterize multimorbidity as this considers the type of diagnoses as well as patient factors in its categories, rather than using condition counts or the presence of specific conditions alone.[40,44] However this system is a measure of total morbidity burden, rather than a measure burden from the chronic conditions and their management alone, as it includes non-chronic conditions and incorporates age and gender. Another framework suggests defining multimorbidity by the etiologic association between diseases and their risk factors, to better understand the causal pathway and potential prognostic and treatment results.[29] This model helps explain the development or multimorbidity, but is limited in measuring it for clinical or research uses.

Piette and Kerr proposed a model that is focused on the treatment interaction between diabetes and co-morbid conditions. In their model of diabetes concordance and discordance, diabetes co-morbid conditions are separated into two groups by pathophysiology and hypothesized effect on diabetes care. Concordant conditions share pathophysiology and should improve treatment or diabetes, and discordant conditions do not share pathophysiology and should worsen diabetes treatment.[42] This model is based on the conditions' pathophysiology and treatment, but allows for the role of patient and provider preferences[29] for care based on overlapping (concordant) care.

This model, and its supporting evidence, is discussed in greater detail in the next chapter.

2.3. The Role of Clinical Practice Guidelines and Quality Metrics

Clinical medicine is now strongly guided by evidence-based practice guidelines developed by consensus groups and health systems. Most guidelines for chronic condition management reflect the single chronic disease paradigm and do not support clinicians in efforts to integrate and prioritize multiple care goals in multiple chronic conditions,[25,45] rather that managing several conditions in series or parallel. This integration is especially important when conditions have diverse and often conflicting management goals.[22,23,32] A guideline's exclusion of patients with multimorbidity becomes more concerning when quality metrics and care improvement interventions are developed from the guidelines. [46]

2.3.1 Clinical Practice Guidelines

Guidelines for diabetes care, such as those from the American Diabetes Association,[47] are better than many chronic condition guidelines as they provide recommendations for individuals with diabetes plus one co-morbid disease such as hyperlipidemia or hypertension.[48] However, these guidelines are silent for the many individuals with diabetes who have conditions that don't share pathophysiology with diabetes, as hypertension and hyperlipidemia do.[25,42] These seemingly less-related chronic conditions also add to the complexity of diabetes care, and diabetes guidelines need to incorporate recommendations for these patients as well.[37] Guidelines also do not

address how interactions between multiple chronic conditions affect the health of the individual throughout the guidelines.[35] As a result, we are unable to provide adequate care for this growing, heterogeneous population.[49,50] Part of the reason for the lack of integration of multiple chronic conditions in single disease guidelines is that most clinical trials exclude those with multiple medical conditions, and therefore, little evidence is available.[38,48] Future clinical trials should include complex patients,[38] however much work can be done with currently available data to assess the impact of multiple chronic conditions on diabetes care quality.[46,51]

Guidelines should consider the risk of morbidity and mortality from diabetes as applied to each specific patient with multimorbidity, as well as the burden of treatment, patient priorities for outcomes, and risk of adverse drug and other treatment effects.[32,34] A recent consensus statement from the American Geriatrics Society suggests a stepwise approach for caring for older adults with multimorbidity that starts with patient and family preferences for care across all conditions, rather than considering conditions independently, then assesses potential benefits, harms and prognoses before proceeding to care recommendations.[52] Considerations for patient preference and integration of multiple care needs is especially important in the elderly,[32,52] it is also important in the middle age population, as almost half of individuals with multimorbidity are under age 60.[9,10] Treatment priorities likely differ between these populations, although adults of all ages clearly desire to enjoy life symptom free and with reduced treatment burden.[53,54] The difficulty and costs of multimorbidity care should be considered as well to reduce time and financial burden of clinical and self-care while

maintaining and improving outcomes (increased efficiency) as per the Institute for Healthcare Improvement Triple Aim.[32,34,55]

2.3.2. Quality Metrics and Public Reporting

Quality metrics, based on aspects of medical care from clinical practice guidelines that have been shown to reduce morbidity and mortality, are now used to assess the professional performance of providers, clinics, hospitals and health systems. The results of the assessments are used in public rankings of the health care entities and internal promotion and pay-for-performance schemes. [56,57] Patients can review the public reporting of quality metrics to help choose where to receive care.[56,58] While they are typically used to measure the performance of health care providers or health systems, they also incorporate the patient's role. This is especially true for measures of control, such as cholesterol control levels that are due to patient medication adherence and lifestyle behaviors, compared to lab testing that is mostly under the provider and system's control. Although controversial, partially due to the lack of individualization and that providers/systems are held responsible for the patient's behavior, public reporting metrics are in general well-accepted by patients and payers and are therefore here to stay.[57]

Achieving current diabetes-specific metrics are associated with improved microvascular and macrovascular outcomes[47,59] and the use of metrics in public reporting has been shown to improve provider compliance with care guidelines.[60] Diabetes metrics include the major aspects of recommended diabetes care, including frequency of HbA1c

testing, level of glycemic control as measured by HbA1c, annual LDL cholesterol screening, level of LDL cholesterol control, blood pressure control, kidney function monitoring, annual eye (retinal) examination, tobacco cessation counseling and foot examination.[59,61] These metrics were chosen for public reporting because they can be measured in a standardized fashion across populations and health systems, there is agreement that achieving these goals leads to better diabetes outcomes, and there is strong evidence that major complications are reduced if these goals are achieved. [47] Evidence has shown a reduced risk of cardiovascular and cerebrovascular events with adequate LDL cholesterol and blood pressure control and tobacco cessation, decreased microvascular complications with glycemic control and early diagnosis and management of retinopathy and nephropathy and decreased amputations with close monitoring of feet.[47]

However, the utility and impact of metric achievement on patient-oriented outcomes depends on how well they reflect optimal diabetes care for the population they serve. Currently the National Committee for Quality Assurance (NCQA)[12] and Health Plan Employer Data and Information Set (HEDIS),[59] among others, do not account for multimorbidity in their diabetes metrics, as guidelines do not account fully for multimorbidity.[25,32,45] Quality metrics that do not take into account multimorbidity can be especially inadequate in the multimorbid elderly where need to avoid hospitalization or surgery (due to patient preference or medical status) or to avoid adverse drug events could conflict with metric achievement.[62] Diabetes care guidelines and their related quality metrics need to include the impact of multimorbidity to serve as an appropriate

basis for performance evaluation for these patients.[35,41] Research to understand the role of multimorbidity in diabetes care can be used to better inform guidelines and the quality reporting metrics derived from them.[63]

2.4. Competing Demands and Prioritizing Care with Multimorbidity

Patients with multimorbidity and their providers are faced with a daunting list of care goals to meet all recommended care for each of the patient's chronic conditions. It is impractical to meet all health care needs at each visit and all self-care needs daily, and therefore some must be prioritized and others will be discounted.[64-66] Understanding which diabetes care goals, and for which chronic conditions, are achieved and which are not, will help inform guidelines and interventions for these complex patients.[15,37,67]

The model of Competing Demands, originally described for preventive services[66,68] and since used for chronic disease,[69-72] explains that a primary care encounter is bounded by time constraints, and multiple patient and provider health concerns vie for available time, leading to lower quality of care as more needs are addressed.[66] As the time needed to adequately address a patient's concerns increases, either due to complexity or number of concerns, either the time for each concern must decrease or concerns must not be addressed at that visit. This model has face validity with practicing primary care physicians who face the challenge of balancing number of appointments per day to meet patient needs and billing benchmarks, while providing enough time in each visit to adequately serve the patient. The realities of current clinical practice mean that not all needed care can be completed during office visits. Guideline-based calculations show

that providers need 21.7 hours/day for a typical patient panel to provide chronic condition management, preventative series and acute care.[73] Chronic care is responsible for almost 11 of these hours.[74] Additionally, an average 19.4 minutes is necessary to provide all necessary diabetes services, rather than the 10 minutes allotted in a typical follow-up office visits, and the time required for diabetes and comorbidity care can increase dramatically when medications are changed, lifestyle is discussed, symptoms are severe or more education is needed.[69]

The model of Competing Demands during office visits has been tested in a few studies with chronic conditions. For instance, among patients with uncontrolled diabetes, each additional clinical encounter agenda item decreases the likelihood of a diabetes medication change by 49%, and if four or more concerns were discussed, diabetes medications were never adjusted.[69] Among patients with diabetes and uncontrolled hypertension, providers were twice as likely to discuss at least one additional chronic condition if chronic pain was not discussed. When pain was discussed, less than one third of providers discussed an additional chronic condition.[75]

The model of Competing Demands should be considered to extend beyond the office visit, as chronic condition care is increasingly occurring between provider visits, through phone calls, electronic messages and visits to ancillary staff chronic care managers.[76] The Patient Centered Medical Home model, an increasingly popular model for primary care delivery, focuses on whole-person, integrated care delivered by a physician-led care team.[77] It encourages patient care between physician visits by nursing staff and

care managers, through the use of patient-disease registries and electronic health records.[78] The model of Competing Demands therefore applies to health care staff and the health system as well as to providers.

The model of Competing Demands should also include the experience of patients at and between health care visits, as they carry the burden of self-care. A patient with diabetes alone is recommended to spend 22 minutes a day on direct diabetes care, including glucose monitoring and foot checks, and an additional 121 minutes a day on other related self-care activities, such as preparing meals, exercise, scheduling appointments and ordering diabetes supplies.[79] If a patient with diabetes also has four other common chronic conditions, recommended care guidelines would require that the patient take 19 medication doses daily at a cost of $406/month, follow a complex diet regimen, and check feet and blood sugar daily.[32] Patients feel competing demands for their self-care time and balancing health care needs with other needs, and often skip recommended self-care.[43,65] The time and financial burden faced by patients increases as co-morbidity number increases as well.[32,39] Further, patients with more chronic conditions face increased challenges participating in their complex care.[34]

Competing Demands also suggests that, in a resource-constrained environment, certain care goals will be completed before other goals, and some goals won't be completed at all. To maximize health, multiple aspects of care must be integrated across conditions and prioritized by both providers and patients through shared-decision making, accounting for patient preferences while optimally reducing morbidity and mortality.[80-

[82,64] Current clinical practice guidelines do not help patients and clinicians prioritize care goals[45] and do not address integration of care in multiple chronic conditions.[23,32] It is unclear where chronic conditions conflict in their care goals and where there is synergy.[42,43,50,80] Finally, there must be shared-decision making that allows for both patient and clinician care priorities.[64,83] Primary care office visits must be long enough and panel size small enough to allow effective patient-provider conversations to adequately integrate care goals for multiple conditions.[84]

Patients might have treatment preferences for their multimorbidity that vary from provider preference, based on symptoms, treatment burden or health outcome goals. Patients might prefer to manage conditions that are most symptomatic first, or select the treatment that is most likely to impact their functional independence.[82,85] For example, a patient with many conditions might prefer to reduce pain before reducing diabetes-associated mortality risk, or decrease treatment burden rather than reducing diabetes complications.[53,54,80,86] Other patients might prefer to reduce treatment burden, especially if they are younger and treatment makes them feel sickly or older.[53] A clinician however, might prioritize longer-term outcomes and also could be influenced by public reporting and pay-for-performance measures.[64,86] Patients might also prefer care that manages multiple conditions or symptoms at the same time.[80,82] To best advise patients with diabetes on how chronic condition management will impact their symptoms, morbidity and mortality risk, we need to understand the impact of their multimorbidity on their diabetes care goal achievement.[25,67] Guidelines and interventions can then be tailored to meet each multimorbid patients' needs.[84,87,88]

2.5. Potential Clinical Applications of Research in Multimorbidity and Diabetes

Understanding how multimorbidity impacts diabetes care and how these complex patients are best managed can inform future diabetes care guidelines and public reporting metrics. Interventions to promote better care for patients with diabetes and multimorbidity, incorporating evidence on the impact of multimorbidity on diabetes care quality, can be based on this research as well. Current interventions to improve chronic condition care, such as Wagner's Chronic Condition Model[89] remain focused on a single condition, without adequate consideration of the impact of additional chronic conditions.[34,37] Interventions to improve care need to understand the entirety of a patient's care needs for their specific mix of conditions, with an approach to incorporate individual patient preferences, to be person-centered and not disease-centered.[35,36]

Interventions could be developed to target patients at-risk for suboptimal care based on their multimorbidity profiles, and designed to improve care by targeting either synergistic care opportunities, likelihood of gaps in care, or both. Interventions to achieve synergistic care goals could target patients who have multiple conditions with a particular set of shared care goals, such as blood pressure control for diabetes, hypertension, ischemic heart disease and chronic renal failure. Interventions could also be designed to target patients who are less likely to achieve a care goal based on their set of multimorbid conditions. For example, patients with chronic pain might be most at risk for suboptimal blood pressure control, and the intervention could target patients with chronic pain to improve blood pressure.[75] Alternatively, patients might be most at risk of suboptimal care if they do not have certain conditions. For example, patients with no

eye disease might be more likely to skip the annual eye exam,[90] and interventions could target patient without eye disease to educate on the need for pre-symptomatic eye exams.[47] Interventions can also be designed to address how patients and providers might prioritize care differently and to encourage shared-decision making around beneftis and risks. If patients with chronic pain prioritize pain control over asymptomatic elevated blood pressure control, while providers prioritize cardiovascular risk management,[86] the intervention could educate providers to address pain control as a first priority and to educate patients explicitly on the need for simultaneous blood pressure control. This allows the intervention to be patient-centered, improving patient adherence and patient-oriented outcomes.[91]

2.6. Summary of Significance of Research on Diabetes Care in Multimorbidity

Multimorbidity that includes diabetes affects 26 million individuals in the US with staggering levels of complications and premature death. Comorbidities complicate already complex diabetes care, increasing cost, time and medication burden. Current clinical practice guidelines, for diabetes and other conditions, do not explain how to integrate care in multimorbidity, compromising outcomes for this vulnerable population. The interactions between chronic conditions and their care goals contribute to the complexity of care for multimorbidity and an understanding of these interactions is necessary to improve care.[29,49] This understanding will allow us to develop approaches to prioritize care in multimorbidity and to select patients for these approaches to improve their health outcomes.[23,83,92,93]

CHAPTER 3: OVERVIEW OF THEORETICAL FRAMEWORK

Goal-based Concordance and Discordance and the Combined Effect of Multiple Factors that Influence Diabetes Care Goal Achievement

3.1 Introduction

The rates of diabetes and multimorbidity are increasing in the US, and multiple efforts are underway to provide improved health care for this complex population. The US Health and Human Services has developed a Strategic Framework on Multiple Chronic Conditions[21] targeted at improving care and improving research in multimorbidity. Expert consensus groups, including an Institute of Medicine group and the Cochrane Collaborative, are working to develop approaches to develop better guidelines and interventions for multimorbidity.[36,51,67,94] However, the lack of knowledge on how multimorbidity affects care in which patients limits this work.[15,49,95]

In order to achieve the objective of better guidelines and interventions, and ultimately better care, in patients with diabetes and multimorbidity, we need a conceptual model for the impact of chronic conditions on diabetes care. Piette and Kerr offer an intriguing model on the concordance and discordance of chronic conditions in diabetes care,[42] however it is insufficient. We build on their work to develop a model that considers that more factors influence a chronic condition's impact on diabetes care, and allows for variation in the impact of chronic conditions between conditions and for different diabetes care goals. A more detailed model could allow for guidelines and interventions to better integrate and prioritize diabetes care goals in the setting of multimorbidity.[48,49]

3.2 Overview of Piette and Kerr's Diabetes Concordance and Discordance of Chronic Conditions Conceptual Model

Piette and Kerr suggest that comorbid conditions can be either concordant or discordant with diabetes management, and that concordant and discordant conditions interact with diabetes care differently.[42] This framework defines concordant conditions as those that have similar pathophysiologic risk profiles as diabetes and have the same management plan; discordant conditions do not have either the same pathophysiology or management, and care can be either not indicated or contraindicated in diabetes. (*E.g.,* hypertension is concordant with diabetes while glaucoma is discordant.)

Piette and Kerr hypothesize that management of concordant conditions will improve diabetes care as concordant conditions share treatments and/or testing with diabetes and could cue providers or patients to complete care. Care for concordant conditions fulfill care needs of 2 or more conditions (the concordant condition and diabetes, plus other conditions that share the care goal), and are a more efficient use of time and effort. Care goals that serve multiple conditions might rightly be prioritized over discordant care goals.[82] Some researchers have suggested is it best to prioritize synergistic care goals rather than goals that only serve one condition when not all recommended care can be provided due to time and budget constraints.[80]

Management of discordant conditions could detract from diabetes care by competing for available time or money, or rarely because treatments pose increased health risk (*e.g.,* use of steroids in poor glycemic control), based on the model of Competing Demands

as applied to providers, patients and the health system. Any care that is not part of diabetes care (*i.e.,* care that is not indicated for diabetes) takes time, attention and money from diabetes care, and is therefore potentially damaging to diabetes care even if the care is not contraindicated in diabetes. This also means that the concordant-discordant framework does not have a neutral category, as no comorbid condition can be neutral to diabetes management if it competes for resources with diabetes care. Conditions are either entirely concordant or entirely discordant with diabetes care, and are also equally concordant or equally discordant to each other.

The concordant-discordant framework provides a classification for patients with multimorbidity with similar treatment plans and those with multimorbidity with disparate treatment plans who are likely to be more complex.[22,38]

3.3 Evidence for Piette and Kerr's Concordance and Discordance Model

Evidence both supports and detracts from the Concordance and Discordance model.[49,50,59-65] Several studies have shown that concordant chronic conditions are associated with improved diabetes care and discordant chronic conditions with worsened diabetes care.[80,90,96,97] However, other studies have shown no improvement[80] or even worsened diabetes care with concordant conditions,[43,98] and no effect[80] or better diabetes care with discordant conditions.[99,100]

3.3.1 Supporting Evidence of for the Concordance and Discordance Model

3.3.1.1 Evidence for good diabetes care with concordance

There is some evidence that the presence of concordant conditions leads to improved diabetes care. In a study of patients with diabetes, grouped by comorbidity type (concordant-only and discordant-only), those with concordant-only comorbidities had better LDL cholesterol control than patients without comorbidities.[80] A study on patients with both diabetes and dementia showed higher rates of HbA1c tests, LDL cholesterol tests and diabetic eye examinations when the patients also had diabetes-concordant ischemic heart disease and peripheral vascular disease.[90] Another study assessed patients' self-report of providers' behaviors and found that patients with concordant conditions, either in combination with discordant or without discordant conditions, were more likely to have their medications reviewed and their blood pressures checked.[96] Among patients with diabetes and uncontrolled blood pressure, HbA1c or LDL cholesterol, concordant conditions were associated with having appropriate follow-up within 6 months.[97]

3.3.1.2 Evidence for poor diabetes care with discordance

Multiple studies on diabetes care quality in the setting of comorbidity have supported the hypothesis that discordant conditions make care more complex and problematic. In patients with diabetes and uncontrolled hypertension, the discussion of chronic pain, a discordant condition, during an office visit was associated with a 40% reduction in odds of blood pressure medication adjustment at that visit.[75] In Australia, military veteran

patients with diabetes were increasingly less likely to have their anti-glycemic therapy intensified as their number of diabetes-discordant comorbidities increased.[101] Patients with both dementia and diabetes were less likely to have received HbA1c tests, LDL cholesterol tests and eye examinations, compared to patients with diabetes only.[90] In another study, patients with diabetes who were post-acute myocardial infarction appropriately had an angiotensin converting enzyme inhibitor (ACEI) prescribed at discharge in 74% of cases. When these patients also had depression, an ACEI was prescribed in only 62% of cases.[102] Patients with diabetes and substance abuse had lower rates of eye exams and sensory foot exams than patients without comorbid mental illness.[99] In a study conducted prior to the Women's Health Initiative Study, women with diabetes were found to be 60% less likely to receive hormone replacement therapy than those without diabetes.[103] Also, patients with diabetes and discordant comorbid conditions had lower diabetes self-care priority and self-management ability.[43] Macrovascular concordant conditions were also associated with lower self-care priority and management ability, and the authors point out that this data was collected before the concordance of macrovascular complications with diabetes was widely known.[43] Among patients with diabetes and uncontrolled blood pressure, HbA1c or LDL cholesterol, discordant conditions were associated with not having appropriate follow-up within 6 months.[97]

3.3.1.3 Supporting evidence for the Concordance and Discordance Model in other chronic conditions

Studies on other chronic conditions also support the concordance-discordance framework. In post-acute myocardial infarction patients (AMI), those with AMI-concordant chronic conditions (hypertension, hyperlipidemia, diabetes) were more likely to meet post-AMI care guidelines than patients with chronic conditions that have low concordance with AMI (COPD/asthma and depression).[102] In the same study that showed reduced rates of hormone-replacement therapy in patients with diabetes, patients with COPD were found to be 30% less likely to receive lipid-lowering medications than patients without COPD, and patients with psychotic syndromes with 41% less likely than those without these syndromes to receive arthritis treatment.[103] In a study on hyperlipidemia, each additional concordant condition (diabetes, coronary artery disease or equivalent, renal insufficiency) was associated with 37% higher adjusted odds of guideline-appropriate care and each discordant chronic condition (ex: osteoarthritis, esophageal reflux, headache) was associated with a 19% lower adjusted odds of guideline-appropriate care.[104] The lower likelihood of appropriate care in the presence of discordant conditions persisted in the presence of concordance conditions. For patients with hypertension, each additional discordant chronic condition was associated with lower odds of hypertension treatment intensification at an office visit. [105]

3.3.2 Detracting Evidence for Concordance and Discordance Model

Despite the evidence supporting the concordance-discordance model, studies have also failed to show that management of concordant comorbidities improved diabetes care or

that management of discordant comorbidities worsened care. In one study, patients with uncontrolled diabetes in the presence of other chronic conditions received anti-glycemic treatment intensification at equal rates regardless of whether the comorbidities were diabetes-concordant or diabetes-discordant.[98] Another study showed no difference between patients with concordant conditions only, and those without comorbidities, for glycemic testing or control, or LDL cholesterol testing, after adjusting for number of office visits.[80] Patients with diabetes and schizophrenia or major mood disorder, discordant conditions, had significantly better HbA1c values than patients with diabetes and no serious mental illness.[100] Another study showed that patients with diabetes and mental health conditions had similar rates of HbA1c and eye exams as patients without mental health conditions.[99] Investigators in yet another study divided patients with diabetes into 4 groups based on diabetes-concordance of specific comorbidities: diabetes-concordant conditions only (hypertension, hyperlipidemia, ischemic heart disease), diabetes-discordant conditions only (arthritis, depression, COPD), both concordant and discordant conditions, and no comorbidities. At baseline, patients with discordant conditions only had better rates of blood pressure control and those with concordant-only conditions had worse rates, than patients with no comorbidities.[97] Patients with diabetes and major mental health issues or dual diagnosis (major mental health and substance abuse) did not have worse diabetes care quality overall than patients without mental health conditions.[99]

3.4 Summary of the Concordance and Discordance Model

Piette and Kerr's concordance framework, as it fits within the concept of competing demands, provides a strong theoretical basis for variations in diabetes care quality for patients with diabetes and multimorbidity. However, the conflicting evidence for the condition-overall concordant-discordant framework model suggests that concordant and discordant comorbidities are not all equal in their effect on diabetes care quality. More detail is needed on the role of concordance and discordance to effectively apply this framework to understand, and ultimately improve, suboptimal diabetes care in multimorbidity. An expansion of the framework can provide this understanding.

3.5 Reasons for discrepancies in the evidence for the Concordance and Discordance Model, and why a new model is needed

3.5.1 More contact with the health system

One explanation for the high quality of care in patients with discordant conditions is that these individuals are more likely to interact with the health care system than those without multiple conditions, and perhaps interact more frequently with it than those with concordant chronic conditions, as the diverse discordant conditions would require more appointments, especially with diverse specialists.[33] A study that divided patients with diabetes into four comorbidity-concordance groups (concordant only, discordant only, both concordant and discordant, and no comorbidities) found that the beneficial effects of comorbidity concordance were tempered by number of annual visits.[80] In the unadjusted model, patients with concordant-only conditions were more likely to have

HbA1c and LDL cholesterol testing. Once the annual number of office visits was added to the model, the effect of concordant conditions was no longer significant but the presence of discordant conditions (alone or in combination with concordant conditions) led to lower odds of receiving these tests.[80] In VA patients with diabetes and non-substance abuse psychiatric disorders, eye exam rates were similar to those for patients with diabetes and no mental disorders while the patients with psychiatric conditions had more annual primary and specialty care visits per year than those without mental illness however.[99] The type of health care visit should be considered as well. In patients with hypertension and other comorbidities, care received from hypertension-discordant specialists (rheumatologists) did not increase the chance of intensified hypertension treatment, whereas care from hypertension-concordant specialists (cardiologists) did.[105]

In studies that have examined the effects of total count of conditions on health care outcomes, not considering the concordance or discordance of conditions, the number of visits has made a difference as well. Two studies found minimally better outcomes for patients with more comorbidities after adjustment for number of office visits,[7,19] suggesting that much of the better outcomes seen in patients with more conditions was due to more frequent interaction with the health care system.[80]

3.5.2 Degree of overlap in care between conditions

The complex, multi-faceted nature of diabetes care could also contribute to the mixed results of these studies. Past studies on the diabetes concordance-discordance

framework considered comorbid conditions as either entirely concordant or discordant with diabetes care, and considered them equally concordant or discordant. Chronic conditions were determined to be either concordant or discordant with diabetes based on the researchers' judgment of the condition's overall management compared to diabetes management as a whole. [42,80,100] However, diabetes care requires achieving multiple care goals, and comorbid chronic conditions could share none, some or all of these care goals, leading to varying degrees of overlap between diabetes care and the care of other chronic conditions.

A condition might be discordant for many diabetes care goals, but still have a small degree of overlap with diabetes care. Glaucoma is one example. While discordant for most aspects of diabetes care, glaucoma and diabetes overlap for specialist eye care.[90] On the concordant side, certain conditions, such as ischemic heart disease, might align with diabetes care for more care goals than other seemingly concordant conditions, such as renal insufficiency. A study on concordance-discordance of comorbidities in post-AMI patients used three categories of concordance for selected comorbidities, from low concordance to high concordance, based on physician judgment of how much overlap existed between the comorbidities and post-AMI care, and found increased quality of post-AMI care with increased concordance level.[102] Concordance and discordance of chronic conditions with diabetes care, therefore, is not as simple as a single overall determination, and certain conditions are likely "more concordant" or "less concordant" with diabetes than other conditions.

3.5.3 Clinical Priorities: Symptoms, Severity and Preferences of Patients and Providers

A weakness of the concordance-discordance dichotomous framework is that it requires each concordant or discordant condition to have the same extent of concordant or discordant impact on diabetes care as the other concordant or discordant conditions. Some conditions, and some care goals, are more important to patients' short-term and long-term health than others. Conditions that are symptomatic or more clinically severe are likely to have a greater impact on a patient's care goal achievement than conditions that are not. Additionally, patients or providers might prefer to treat symptomatic or clinically severe conditions before treating milder conditions, or asymptomatic and not severe conditions for other reasons, such as public reporting.[82]

Piette and Kerr did describe a symptomatic domain and a clinical dominance domain in their model in addition to the concordance-discordance domain.[42] The symptomatic domain is simply whether the condition is symptomatic (*e.g.* esophageal reflux) or not (*e.g.,* hypertension). Symptomatic conditions can be relatively benign in terms of complications, but disrupt a patient's well-being and require management to reduce the symptom burden. Clinically dominant conditions are those with severity sufficient to appropriately eclipse other care, such as end-stage disease, severely symptomatic or recently diagnosed severe conditions (*e.g.,* end-stage renal failure, severe depression or newly-diagnosed rheumatoid arthritis).

In the Piette and Kerr framework, the symptomatic and clinical dominance domains were kept separate from the concordance-discordance domain. In reality, the concordance-discordance, symptomatic-asymptomatic, clinically severe-not domains are expressed simultaneously, so that a condition can be, for example, concordant, asymptomatic and clinically dominant. Considering only the concordance-discordance domain when we study multimorbidity does not allow us to see the full impact of a condition on diabetes care as it leaves out the role of symptoms and clinical dominance, as well as other unmeasured factors.

For example, in advanced dementia, a symptomatic, severe and discordant to diabetes condition, it is reasonable to not provide all usual diabetes care and the lack of diabetes care goal achievement in this case is due to factors beyond the discordance of dementia with diabetes care.[90] Patients with diabetes and clinical severe conditions, such as end-stage renal failure, were less likely to have quality glycemic and cholesterol care than patients with no comorbidities, or non-clinically dominant concordant or discordant comorbidities.[80] Also, patients with diabetes and with severe heart failure, compared to mild heart failure, were less likely to prioritize diabetes self-care.[43]

Patient and provider preference for care is also not considered in the concordant-discordant model, although patient and provider priorities would likely drive discussions regarding clinical and self-care. Patients and providers might prioritize care based on symptoms or condition severity. For example, patients with severe chronic pain might prefer to manage pain prior to managing blood pressure in diabetes, and a provider

might agree that pain control is necessary for blood pressure control.[75,86] In a study comparing incident versus prevalent diabetes-concordant conditions, providers intensified blood sugar treatment for patients with uncontrolled diabetes who had a new-onset diabetes complication.[98] In another study, patients with microvascular diabetes complications were found to place higher self-care priority on diabetes care goals than were patients without these complications.[43]

Additionally, patients and providers might prioritize care for reasons other than care concordance, symptoms and clinical dominance domains, and so it is insufficient to only consider these domains. Patients might prioritize other life obligations or conditions that they perceive as the greatest threat to their health, even if this isn't the most concerning threat clinically.[65,86] Some patients might prefer to decrease medication burden or improve functional ability rather than reducing diabetes complications or mortality.[53,54,80] Cost and socioeconomic factors may influence a patient's priorities.[106] Providers might be influenced by public reporting and pay-for-performance measures.[64] Finally, contextual elements beyond priorities, such as access to care and the patient's cultural-social environment, have a role as well.[36,107]

3.6 Enhanced Framework: Goal-based Concordance and Discordance and the Combined Effect of Multiple Factors that Influence Diabetes Care Goal Achievement

We propose to expand Piette and Kerr's framework to determine concordance and discordance by overlap in diabetes care goals. We further propose to incorporate the role of other unmeasured factors, such as symptoms, clinical dominance, and patient and provider preference for care, to more fully describe the impact of chronic conditions on diabetes care. In this model, chronic conditions are related to suboptimal or optimal diabetes care through a combined effect of multiple factors that are characteristic to that condition, including symptoms, clinical dominance and patient and provider preference for care. A condition could be related to optimal care for one care goal, suboptimal for another and have no relationship with a third care goal. The additional detail provided by the goal-based combined effect of multiple conditions conceptual model will allow us to target guidelines and interventions to patients most at-risk for suboptimal diabetes care for specific care goals based on their comorbidities.

3.6.1 Goal-Based Concordance and Discordance

The first component of the new framework is the use of goal-based concordance and discordance. Diabetes care requires achieving multiple care goals, and if diabetes is broken down to its care goals, we can determine diabetes concordance or discordance at a care goal level. A condition's concordance or discordance with diabetes care can

be described by the degree of overlap in care goals between diabetes and the comorbid condition

In our framework, a comorbid chronic condition can share a certain care goal (overlap in care for that care goal) with diabetes, and not share another care goal with diabetes. (Figure 3.1).

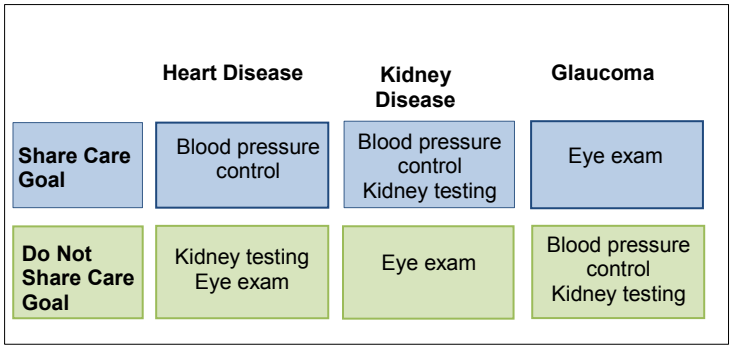

Figure 3.1. Example of Shared Care Goals for a patient with diabetes, heart disease, hypertension, kidney disease and glaucoma. This patient has diabetes as well as heart disease, chronic kidney disease and glaucoma. Three diabetes care goals shown: blood pressure control, annual eye exam and annual kidney testing. The examples in this are based on hypothesized goal-concordance and goal-discordance for a few exemplar conditions and goals. To determine diabetes concordance or discordance, all care goals on interest would be assessed, and conditions with a high degree of overlap would be concordant. Conditions with low overlap would be discordant.

This approach shows that a condition can be discordant with diabetes and still share some care goals, and could potentially allow a condition that might not seem concordant with diabetes when viewed from an overall perspective to be concordant when determined based on shared care goals. There is some evidence for this approach. In a study of patients with diabetes and dementia, the likelihood of receiving an eye exam was highest among those with diabetes and dementia who also had chronic eye

disease.[90] In another study, patients with diabetes and schizophrenia had HbA1c values that were significantly lower than in those with diabetes only, perhaps reflecting increased attention to glycemic control in patients on anti-psychotic medications.[100]

Conditions are determined to be concordant or discordant with diabetes based on the amount of overlap in care goals, rather than simply by a general understanding of similar management. If a condition is concordant for the majority of diabetes care goals, it is concordance with diabetes. If the condition is discordant for the majority of diabetes care goals, it is discordant. Using the shared care goals approach allows for more detail in determining concordance and discordance. It also allows for concordance and discordance to be determined based on the care goals of interest. In this study, the guideline-recommended diabetes metric care goals are used to determine shared management between diabetes and multiple comorbid conditions.

3.6.2 Model of the Combined Effect of Multiple Factors that Influence Diabetes Care Goal Achievement

The second component of this model is to consider whether an individual condition is related to optimal or suboptimal diabetes care. Examining the impact of an individual condition on diabetes care allows a combination of multiple factors, such as concordance-discordance, symptoms and patient preference for care, to determine the overall impact of the condition on diabetes care. The relationship of the condition to diabetes care can be examined for multiple individual diabetes care goals, and the

strength of the relationship can vary between individual chronic conditions and care goals for each condition.

This model also allows conditions to have no significant relationship to diabetes care. It is conceivable that some conditions that are symptomatically mild with minimal morbidity risks, for example, mild esophageal reflux, would have no relationship to diabetes care goal achievement.

Chronic conditions can influence diabetes care goal achievement through their presence (competing demands),[66] concordance or discordance with diabetes care goals, symptoms,[42] clinical dominance, and through patient and provider preference for care.[82] Other factors that are characteristic to the condition, including system factors that encourage or create barriers to care, such as chronic condition registries, pay-for-performance or public reporting, also play a role.[57,60,108] These condition factors must be considered simultaneously, rather than separately, to fully account for the impact of chronic conditions on diabetes care. The combination of all factors leads to the impact of the comorbidity on diabetes care (Table 3.1).

Chronic Condition	
Factors that are characteristic to the condition	
Goal-level concordance or discordance	Provider preference
Symptoms	Chronic condition registry and care manager
Severity	Pay-for-performance
Patient preference	Public reporting

Table 3.1. Multiple factors that are characteristic to a condition that are combined to determine the conditions' impact on diabetes care goal achievement

Additional environmental and contextual factors can also play a role in influencing the care a patient receives and the patient's outcomes.[36] Environment and contextual factors include a patient's social-cultural environment, physician environment, access to care (distance to clinic, clinic hours, out-of-pocket expenses, etc), health literacy, and health beliefs. [107,109] These factors can influence care in multiple ways, including by altering patient (and potentially provider and system) preferences for care. For example, a patient who doesn't believe in the benefits of LDL cholesterol control, is at work throughout the clinic lab hours, and has a high copay and limited income might prefer not to have cholesterol testing done. The main focus of this study is the impact of the multimorbid conditions on diabetes care, for patient with diabetes. Specific factors that influence diabetes care, beyond the presence of a certain comorbidity and its care goal overlap with diabetes, will not be explicitly measured in this study.

As this model focuses on the impact of the chronic conditions on diabetes care due to multiple factors, this relationship with optimal or suboptimal care might or might not align with what is expected from goal-based concordance and discordance. For instance, it could be that a condition with much care goal overlap (concordance) would be related to suboptimal diabetes care due to the influence of clinical dominance and patient preference. An example is congestive heart failure, a clinically dominant condition that a patient might prefer to treat due to symptoms or concerns for morbidity from decreased heart function at the expense of glycemic control treatment. However, another condition with little care goal overlap with diabetes (discordance) could be related to optimal diabetes care goal achievement due to its symptomatic nature and provider preference

to complete care that is publically reported and that happens to be shared with diabetes. For example, pneumonia, a symptomatic condition, shares the pneumococcal vaccination care goal with diabetes and pneumonia might be associated with achievement of the pneumococcal vaccination care goal in diabetes.

The relationship of each multimorbid condition to diabetes care goal achievement, resulting from the combined effect of multiple factors, including overlap in care goals, could be visualized as an expansion of the Boyd and Fortin multimorbidity diagram (Figure 3.2; Figure 2.2, Chapter 2)

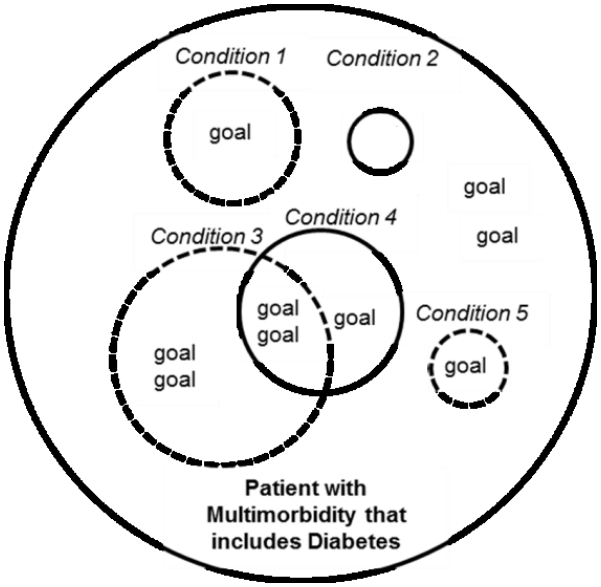

Figure 3.2 Conceptual Model of the Combined Effect of Multiple Factors that Influence Diabetes Care Goal Achievement. Each bubble represents a different comorbid chronic condition in a patient with diabetes. The bubbles each contain the diabetes care goals relevant to that comorbid condition. Care goal overlap between comorbid conditions is shown by overlapping bubbles (goal-based concordance). Goals relevant to diabetes only (and not to comorbid conditions) are shown outside of any co-morbid condition bubbles. The size of the condition bubble represents the magnitude of the impact of that condition on the achievement of diabetes care goals overall. A solid line represents a relationship with *optimal* diabetes care, and the dashed line represents a relationship with *suboptimal* diabetes care.

This model suggests reasons for a relationship between chronic conditions and care goal achievement, but it does not imply causality, nor does it imply appropriateness of care delivery. Certainly, clinically dominant conditions that do not share care goals with diabetes, such as a multiple sclerosis or dementia, could distract a provider or patient from diabetes care. This might be accidental or an intentional choice for that patient. It is also possible that certain conditions could result from poor diabetes care, such as eye disease, rather than causing poor diabetes care. Understanding the relationship of chronic conditions to diabetes care goal achievement, and potential factors that influence this relationship, is a starting point to assess and explain diabetes care quality in multimorbidity.

3.6.3 Clinical Applications of the Goal-based Concordance and Discordance and the Combined Effect of Multiple Factors that Influence Diabetes Care Goal Achievement

The importance of this approach is in its ability to help us identify key conditions associated with optimal or suboptimal diabetes care, and that it suggests how to conceptualize the combined impact of all conditions in a patient's multimorbidity profile on their diabetes care quality. The goal-based concordance and discordance provides clinically relevant detail beyond what is available from a simple count of non-goal based concordance and discordance. More importantly, the model of the combined effect of multiple factors conceptualizes the impact on diabetes care of multiple factors that influence clinical care in the presence of each chronic condition. This framework will lead to an improved understanding of the role of multimorbidity in diabetes care that can

then be used to enhance clinical guidelines and to develop and target clinical interventions to improve diabetes care in patients most at risk for suboptimal care based on their multimorbidity profiles.

Care guidelines must integrate care goals for multiple chronic conditions and explicitly prompt clinicians to provide multimorbid care in order to be effective as a basis for clinical care, interventions and performance metrics.[41,49,67] If we understand which conditions put patients at-risk for suboptimal care for which diabetes care goals, these conditions can be specifically mentioned in diabetes care guidelines in that care goal's section. As it is not feasible for patients to receive all chronic condition care in a single clinic visit, or to conduct all recommend self-management balancing other health and personal obligations between visits, guidelines can provide comments to aid care prioritization and shared-decision making. The guidelines could also highlight if a care goal benefits multiple conditions through goal-level concordance as achieving this care goal might be preferred by some patients and providers, over achieving care that benefits only one condition.[82] Performance metrics could also be modified to reflect the relationships of individual conditions with diabetes care goal achievement, to compare care quality by comorbidity and to highlight potentially inappropriate versus potentially appropriate lack of goal achievement. [35,41]

Interventions in multimorbidity should help patients integrate all care needs and balance the potential benefits and harms of meeting each care goal, or deferring or refusing it.[25,94] The model of combined effects can show which comorbid conditions are

associated with optimal or suboptimal care for multiple individual diabetes care goals. It also provides a method to conceptualize the shared and non-shared diabetes care goals across all each patient's conditions. With this model, patients and providers are able to see which care goals are less likely to be achieved in the setting of the patient's multimorbidity profile, and which conditions each care goal might benefit, so that they can discuss the benefits of achieving each care goal, for diabetes and any other conditions that share the goal, and the potential harms (cost, pain, risk to other conditions). For example, if a patient with diabetes has obesity and lupus, which hypothetically puts them at risk of not achieving blood pressure and glycemic control, and they see that blood pressure control is a goal for three conditions, while glycemic control is a goal for only one condition and could lead to potentially harmful hypoglycemia, they might decide to improve blood pressure control and relax glycemic control. Interventions can guide patient self-management as well by integrating care goals and highlighting self-care that is most necessary to improve their outcomes, either because the self-care benefits multiple conditions or is most likely to be missed in patients with their comorbidities. Finally, patients can be identified for specific interventions based on their multimorbidity profiles and the association their diabetes comorbidities have with specific diabetes care goal achievement. This identification can be done automatically though the electronic health records or chronic condition registries.

Interventions could also be developed to improve care for patients with diabetes and certain comorbidities. Patients with the same dyad or triad of conditions (e.g., diabetes,

depression and obesity) could receive the same intervention as these patients would all have similar care goals and risk of suboptimal care related to their conditions, and might benefit from similar management approaches.[11,15] This framework demonstrates which conditions have little or no impact on diabetes care as well. The management of these conditions could take a lower priority to the management of other conditions, and these conditions could be discounted when identifying patients with multimorbidity profiles that put them at-risk for suboptimal diabetes care.

Additionally, the appropriateness of a conditions' relationship to suboptimal diabetes care can be clinically assessed and used to inform interventions. For example, if dementia is associated with suboptimal glycemic control diabetes care, it might be considered an appropriate lack of goal achievement, and diabetes care interventions for that patient would focus on preventing hypoglycemia. Alternatively, if migraines are associated with suboptimal blood pressure control, it might not be considered an appropriate lack of goal achievement, and diabetes care could focus on improving blood pressure control while managing the patient's pain and reducing migraine occurrence.

Finally, health care delivery could be modified to improve care in multimorbidity that includes diabetes. As it seems that opportunities for care improve the care received in multimorbidity, we might find that increasing number of office visits, or even phone calls, for patients with diabetes and certain comorbidities could be an effective and efficient intervention. Chronic care management could shift focus from individual conditions, with disease-specific registries and care managers, to multimorbidity with registries and care

managers for the most common dyads and triads of conditions that are related to suboptimal care.[15,110]

3.7 Conclusion

Multimorbidity in patients with diabetes is increasing, with staggering levels of complications and premature death. Current clinical practice guidelines, for diabetes and other conditions, do not explain how to integrate or prioritize multiple care goals in multimorbidity. Providers and patients are left with limited care guidance and no interventions to improve care.[94] Understanding the interaction between the care for diabetes and co-occurring chronic conditions is necessary to develop approaches to integrate and prioritize care in multimorbidity and to select patients for these interventions, as identified by the US Health and Human Services Strategic Framework on Multiple Chronic Conditions.[21] This goal-based concordance-discordance framework allows specific diabetes care goals to be addressed in interventions, targeting patients with potentially harmful number and mix of concordant and discordant conditions for different care goals. Further, the combined effect of multiple factors framework highlights conditions that are related to suboptimal diabetes care beyond the impact seen with concordance or discordance, so that patients with these conditions can be targeted to improve their care quality.[67,15]

CHAPTER 4. HYPOTHESES

Hypotheses for each specific aim are summarized below. These hypotheses are based on the evidence and expert opinions discussed in Chapter 2 and Chapter 3, as well as the conceptual model described in Chapter 3.

4.1. Determine the perceived concordance and discordance of chronic conditions with specific diabetes care goals based on primary care provider consensus opinion of outpatient chronic condition management.

Hypothesis: The same condition may be perceived as concordant or discordant for each separate diabetes goal. Patterns of goal-based concordance and goal-based discordance will vary by chronic condition. Summary concordance or discordance can be determined from summary of the concordance and discordance of the care goals.

Rationale: Diabetes care encompasses multiple testing and treatment goals,[24] and each comorbidity may be concordant or discordant with one diabetes care goal and not another care goal. Piette and Kerr conceptualize concordance as occurring when conditions have similar treatment plans as diabetes.[42] Summary concordance, defined as when a condition shares the majority of several diabetes care goals with diabetes, allows a detailed method to determine similar treatment plans.

4.2. Identify patients at-risk for suboptimal diabetes care based on the number and mix of concordant and discordant conditions in the patient's multimorbidity profile.

Hypothesis 2: Concordant conditions will be associated with more diabetes goal achievement as these conditions will support the achievement of shared care goals goal. Discordant conditions will be associated with less diabetes goal achievement, as these conditions will vie for provider and patient resources during and between clinic visits.

Rationale: Piette and Kerr's conceptual model of Concordance and Discordance, developed on elements of the model of Competing Demands,[66] suggests that patients with more concordant conditions will receive better diabetes care due to provider cuing to provide the same care for both condition.[42] Providers and patients might also prefer synergistic care.[43] Patients with concordant conditions might also receive better diabetes care due to a greater sense of urgency in both the patient and the provider to optimize diabetes care when patients already have diabetic complications.[43,82,98] Discordant conditions will distract providers and patients from completing diabetes care and compete for limited time, energy and financial resources needed to achieve these diabetes care goals.[42,66]

4.3: Determine empirically which individual conditions are related to optimal or suboptimal diabetes care goal achievement, and compare to the expected effect based on each condition's perceived concordance or discordance.

Hypothesis 3: Different conditions will be related to optimal or suboptimal diabetes goal achievement, while others will have no relationship to diabetes care goal achievement. Some conditions will be related to optimal care for certain goals and related to suboptimal care for other goals. Whether the condition is related to optimal or suboptimal diabetes care goal achievement will partially coincide with each condition's concordance or discordance for the specific diabetes care goal, with an impact from other unmeasured factors such as condition severity, symptoms, and patient and provider preference for care.

Rationale: There are multiple factors associated with individual chronic conditions that can influence diabetes care goal achievement and determine if a condition is related to optimal or suboptimal diabetes care. Concordance or discordance with diabetes, as determined using the overlap in care goals, is one factor.[42] However, conditions can also influence diabetes care through their severity (clinical dominance),[42] symptom burden[42] and through patient and provider preference for care.[82] The combined impact of these multiple factors, and other unmeasured factors, could result in a condition being related to optimal care, related to suboptimal care or not related to care, for each of several diabetes care goals.

CHAPTER 5. SUMMARY OF PAPERS

Manuscript 1: Establishing chronic condition concordance and discordance with diabetes: a Delphi study

The objective of this study was to use primary care expert opinion to establish the concordance and discordance of chronic conditions with diabetes. We used a modification of the qualitative Delphi technique, with a group of family and internal medicine providers. We asked them to decide if five diabetes care management areas were also care goals or not for a comprehensive set of 62 chronic conditions, excluding diabetes. The conditions chosen are further explained in Appendices 1 & 2. We then used the providers' consensus of goal-level concordance or discordance to determine if a condition was concordant or not with diabetes care overall, based on the number of care goals it shared with diabetes (summary concordance or discordance). There was no neutral category. The majority of the conditions, 50, were discordant with diabetes, and 31 were discordant for all care goals. Twelve conditions were concordant, and 6 of these were concordant for all but one care goal. The results of this study show the varying degrees of overlap in care between diabetes and other chronic conditions, and that diabetes concordance and discordance is not strictly all-or-none.

Manuscript 2: The Impact of a Patient's Concordant and Discordant Chronic Conditions on Diabetes Care Quality Measures

The goal of this study was to determine the effect of concordant and discordant chronic conditions on diabetes care goal achievement for patients with diabetes as a new method to describe multimorbidity and its impact on diabetes, and to identify patients at risk of suboptimal care due to their multimorbidity profiles. We used the concordance or discordance for 62 chronic conditions that we established in paper 1, and then calculated a count of concordant and a count of discordant conditions for each patient in a sample of 24,430 adult patients with diabetes (additional detail in Appendix 5.) We fit logistic regression models, adjusted for patient socio-demographic factors and number of office visits, for 8 diabetes quality care outcomes: HbA1c testing, LDL cholesterol testing, kidney testing, all testing, HbA1c control, LDL cholesterol control, blood pressure control, and all control. We determined that a higher number of concordant conditions (2-3 or 4+, compared to 0-1) was associated with diabetes care goal achievement for all care goals except blood pressure control which was worse with more concordant conditions. Discordant conditions had minimal to no effect on diabetes care goal achievement, except cholesterol testing which was less likely with 4+ discordant conditions. Patients with fewer concordant conditions in their multimorbidity profiles seem to be the most at-risk for suboptimal diabetes care, and discordance plays less of a role in diabetes care quality than we expected. Future care guidelines and interventions could target patients with fewer concordant conditions to ensure they receive optimal care.

Manuscript 3: The Relationship of Individual Comorbid Chronic Conditions on Diabetes Care Quality

The purpose of this study was to determine which individual chronic conditions were related to optimal and to suboptimal diabetes care goal achievement, and which had no relationship with care goal achievement. Examining the relationship of individual conditions on diabetes care goals achievement, rather than using counts of conditions, allows each condition to have a different magnitude in its effect, and allows us to assess if conditions considered concordant or discordant by their shared care goals are related to optimal and suboptimal care, respectively. We examined diabetes care goal achievement for 6 diabetes care goals, HbA1c testing, LDL cholesterol testing, kidney testing, HbA1c control, LDL cholesterol control, and blood pressure control, for 24,340 adult patients with diabetes. We fit logistic regression models for each of the outcomes, adjusted for patient socio-demographic factors and number of office visits, using indicator variables for the presence (or absence) of 62 chronic conditions. Several conditions were related to suboptimal HbA1c, LDL cholesterol and blood pressure control, while numerous different conditions were supportive of HbA1c control only. Most conditions that were related to suboptimal testing were related to suboptimal LDL cholesterol testing. One third of the conditions had no relationship to diabetes care goal achievement. Diabetes care improvement interventions in the setting of multimorbidity should consider the relationship of specific chronic conditions to diabetes care goal achievement for control goals and LDL testing.

CHAPTER 6. PAPER 1: ESTABLISHING CHRONIC CONDITION CONCORDANCE AND DISCORDANCE WITH DIABETES: A DELPHI STUDY

Abstract

Background: The vast majority of patients with diabetes have multiple chronic conditions, increasing complexity of care; however, clinical practice guidelines and public reporting metrics do not address how to integrate care of these multiple conditions. To advance understanding of the care of diabetes in the context of multiple chronic conditions, we must understand how care overlaps, or doesn't, between diabetes and its co-occurring conditions. This study aimed to determine which chronic conditions are concordant and discordant with diabetes care, according to primary care provider expert opinion.

Methods: Using a qualitative methodology, the Delphi technique, we administered an iterative, two-round survey to practicing primary care providers. The expert panel determined which specific diabetes care goals were also care goals for other chronic conditions (concordant) and which were not (discordant). Our diabetes care goals were those commonly used in quality reporting and the conditions were 62 ambulatory relevant conditions categories that we modified from a well-known set of condition categories.

Results: Sixteen experts participated and all completed both rounds. Consensus was reached on the first round for 94% of the items. After the second round, 12 conditions

were concordant with diabetes care and 50 were discordant. Of the concordant conditions, 6 overlapped in care for 4 of 5 diabetes care goals and 6 overlapped for 3 of 5 diabetes care goals. Thirty-one discordant conditions did not overlap with any of the diabetes care goals, and 19 overlapped on only 1 or 2 goals.

Conclusions: This study significantly adds to the number of conditions for which we have information on concordance and discordance for diabetes care. The results can be used to improve care in patients with diabetes and multiple chronic conditions and advance clinical practice guidelines and public quality reporting from the old single-disease paradigm to the clinical reality of multiple chronic conditions.

Background

Most adults with diabetes have at least one other chronic condition, and a quarter have more than 5 other conditions.[7,82,111] Comorbidity interrelatedeness, the degree to which multimorbid conditions and their management interact, affects care management and may influence quality of care. However, we know little about which comorbidities may improve or inhibit optimal diabetes care.[42,49] Current diabetes care guidelines reflect this gap in knowledge and do not integrate comorbidities care or comment on how comorbidities may influence diabetes care. When caring for multimorbid patients, the application of single-condition guidelines may lead to the provision of contradictory and potentially harmful care. Diabetes has been the focus of numerous national and system level quality improvement and public reporting efforts, so it is particularly valuable to understand the influence of comorbidities in this context.[60,112]

An understanding of the impact of multiple chronic conditions on diabetes care is urgently needed to develop appropriate interventions to improve diabetes care. A potentially valuable approach to integrating diabetes care with the care of its comorbidities is to consider comorbidities as concordant or discordant with diabetes care. In this general framework, conditions that share the same overall pathophysiologic risk profile as diabetes are concordant with diabetes and could cue providers to provide the same or similar care as required for diabetes management, resulting in better diabetes care. [42,80] Discordant conditions do not cue providers to provide recommended diabetes care and may distract from diabetes care. When a discordant condition is present, time limitations, competing demands, and other challenges may cause patients

with diabetes to receive lower quality care for diabetes and the discordant condition as compared to having a single condition alone. [49,80] This framework could allow providers to target patients with multiple chronic conditions who are most at-risk for suboptimal diabetes care based on having fewer concordant conditions or more discordant conditions.

While previous investigators have attempted to test the Piette and Kerr framework, they have been limited by the lack of a comprehensive list of diabetes concordant and discordant chronic conditions. Previous investigators have categorized a limited number of conditions and have used context experts, researchers, and clinical practice guidelines to determine the concordance/discordance of each condition with diabetes. [42,113] These categorizations have considered comorbidities as entirely concordant or discordant with diabetes. [42,80,100] However, diabetes care is complex and encompasses multiple testing and treatment goals. [24] Each comorbidity may be concordant or discordant with one diabetes care goal and not for another. For instance, glaucoma may be concordant with the annual eye exam goal and discordant with the A1c testing goal.

Our study aimed to advance the usability of the concordant-discordant framework for clinical and research use. We determined diabetes concordance and discordance of chronic conditions with respect to individual diabetes care goals to understand the overlap of care at the goal-level. Our study is additionally unique in that it used the Delphi methodology to determine concordance and discordance from primary care expert opinion for a comprehensive set of chronic conditions.

We aimed to provide researchers with a much needed tool to examine how comorbid chronic conditions might impact diabetes care. Understanding how chronic condition care overlaps with diabetes care will help prioritize care for patent with multiple chronic conditions and highlight which care goals, conditions and patients might be at-risk for suboptimal care due to limited overlap in care.

Methods

Overview

We used Delphi methodology, [113-117] a technique that has been well-studied and was developed by RAND and is the basis for the RAND Appropriateness Method. [118] This technique is most effective when there is a lack of or inadequate information about an issue, [115] such as exists in the literature defining chronic conditions as concordant or discordant with diabetes. Compared to committees and meetings, which can be dominated by a single individual, this technique considers all respondent's opinions through anonymous reporting and feedback. [115]

Practicing PCPs formed our expert panel over two rounds of surveying, after the survey was pilot tested in a separate group of clinician experts. In the survey, we asked the experts to state whether specific diabetes care goals aligned with care goals for a comprehensive set of outpatient-relevant chronic conditions.

This study was approved by the University of Wisconsin Health Sciences Minimal Risk Institutional Review Board and informed consent was given by all participants.

Diabetes care goals

Diabetes care is complex and involves management of multiple care goals. We chose diabetes care goals that are related to short- and long-term health outcomes in diabetes, and are measured by state and national diabetes performance metrics. [59] These diabetes goals represent the pathophysiologic spectrum of diabetes, from microvascular to macrovascular involvement.[12,24,59] The 6 diabetes care goals were: glycemic management, LDL cholesterol management, blood pressure management, kidney function monitoring, annual eye exam, and tobacco cessation counseling.

Chronic Conditions

We built a list of 62 outpatient-relevant chronic condition categories from a set of chronic conditions previously used in multimorbidity research.[30,31] and based on the AHRQ clinical classification system (CCS) of medical conditions. We further modified this set of condition categories to enhance the representation of cardiovascular, metabolic and mental health conditions by separating out conditions in these categories. Our 62 chronic condition categories encompass 1,412 ICD-9 codes. We counted a patient with multiple chronic conditions (multiple ICD-9 codes) within any single CCS category as having one chronic condition.[30,31]

Expert Panel

The Delphi technique allows for selection of experts and does not require a representative sample of the response population, so selection bias in not an issue with this technique. It also does not require a certain sample size, although most Delphi surveys use 10 or more panelists.[115]

We contacted local primary care providers to serve as experts for our Delphi survey by an IRB-approved recruitment email. We surveyed 16 PCPs who care for adult patients with chronic conditions at clinics affiliated with a large Midwestern academic medical center. All experts completed both rounds of the survey. The PI did not serve as an expert for the Delphi survey to avoid biasing results, and also did not participate in initial analysis of collected results. We included general internal medicine and family medicine physicians, physician assistants, and nurse practitioners. We chose practicing PCPs because they offer expertise in the management and care coordination of diabetes, along with a spectrum of multiple other chronic conditions.

Delphi Survey Procedure

Using a web-based survey to reduce undue peer influence on responses,[113,116] we asked providers if each listed care goal was indicated or not in the management of each of the listed conditions. The respondents remained anonymous to one another. "Management" was explained as any testing or treatment that the provider would do beyond care for a normal, healthy individual. The first-round survey listed 62 categories of conditions and 6 care goals, for a total of 372 condition-goal survey pairs. (See

Appendix 1.) Diabetes was not listed on the survey and the care goals were not described as diabetes care goals to reduce the chance that respondents would think the hypothetical patient had both the listed chronic condition and diabetes.

Analysis

We determined diabetes concordance and discordance both on a goal- and summary-level for each chronic condition.

Determining goal-level concordance and discordance

Goal-level concordance of a chronic condition was defined as provider consensus opinion that a diabetes care goal was indicated for the chronic condition. If the care goal was not indicated, that condition had goal-level discordance with diabetes. Conditions could be discordant for one care goal and concordant for another.

Provider consensus opinion was determined using a 60% majority opinion threshold for concordance by the end of the second round of the iterative survey. In the Delphi Method, the percentage agreement required to establish consensus is not definitive and typically ranges from 50-80%. [114,119-126] where consensus levels higher than 80% are of unclear benefit. [114,123] Figure 1 depicts our analysis process. We chose a 60% cut-off because at a higher threshold, over half of respondents would have to change their opinions on a specific care goal to move the majority opinion from concordant to discordant. As this is highly unlikely, we concluded that a 60% majority opinion accurately determines goal-level concordance for a given condition-goal pair. All other

care goal-condition pairs were considered discordant as under Piette and Kerr's model of concordance and discordance,[42] *i.e.* any condition that is not concordant with diabetes care is considered discordant without needing a separate discordance threshold. The cut-offs (60%) were determined prior to seeing results, so that consensus threshold was not influenced by the survey results.

After the first round of surveying, condition-goal pairs that did not reach the consensus threshold were re-addressed in a second survey round. We used 2 rounds of the survey to determine consensus opinion as additional rounds have been shown not to be helpful.[115] The second round surveys were individualized, based on each respondent's unique responses, to include only those condition-goal pairs for which the respondent was not in the majority opinion. The second round was conducted in waves, starting with those respondents who needed to be asked the fewest questions. As items reached consensus through the iterative process, they were dropped from further waves in round 2. This limited the time burden on participants and potential burn-out.[115] Condition-goal pairs that did not reach the 60% consensus threshold for concordance after the second round were defined as discordant.

Summary-level concordance and discordance analysis

We determined each chronic condition's summary-level concordance or discordance by assessing whether a majority of care goals were concordant or discordant for each condition. Conditions that were concordant for the majority of care goals were established as having summary-level concordance with diabetes, and vice versa for discordant conditions.

Results

Our study sample included 16 PCPs. Twelve were family medicine physicians, 2 were internal medicine physicians, 1 was an internal medicine physician assistant, and 1 was an internal medicine nurse practitioner. Most had more than 10 years of practice experience.

After the first round of surveys, 339 of the 372 condition-goal pairs were categorized as concordant or discordant. Thirty-three condition-goal pairs did not reach consensus and went to the second survey round. After the second round of surveying, 9 condition-goal pairs of the 33 remained below the 60% concordance threshold and were declared discordant.

Unsurprisingly, the tobacco cessation counseling goal was unanimously indicated (concordant) for all conditions in the first round. As such, it could not be used to discriminate between conditions based on diabetes concordance, and was excluded from use in determining summary-level concordance. Therefore, summary-level concordance and discordance were established when 3 out of 5 goals were concordant or discordant, respectively.

In the final analysis at the summary-level, 12 conditions were concordant with diabetes and 50 were discordant (see Table 1).The largest clinical group for concordant conditions was cardiovascular, whereas discordant conditions were distributed across

multiple clinical groups. Six conditions (acute myocardial infarction in past 2 years, coronary atherosclerosis, peripheral atherosclerosis, hypertension, cerebrovascular disease, and chronic renal failure) showed goal-level concordance for all 5 goals except eye exam. The other six concordant conditions (congestive heart failure, cardiomyopathy and structural heart disease, thrombosis and embolism, hyperlipidemia, polycystic ovarian syndrome, and obesity) were also discordant for eye exam, as well as either blood sugar management or kidney function monitoring. Thirty-one discordant conditions were discordant on all 5 goals; and 19 were discordant on all but 1 or 2 goals. See Table 2 for detailed goal-level results.

Discussion

Among 62 ambulatory care-relevant chronic conditions, 12 conditions were concordant with diabetes care, overlapping on at least 4 out of 5 care goals. These conditions are diabetes risk factors or complications. The remaining 50 conditions were discordant, showing limited overlap with diabetes care goals. Of these, 31 conditions overlap on none of the 5 major diabetes care goals used in this study. As most patients with diabetes have at least one additional chronic condition, and our results show that not all conditions are equal in how the interact with diabetes care, our work has implications for clinical care, clinical practice guidelines, and public quality reporting.

Our application of the Delphi Methodology and assessment of goal-level and summary-level concordance and discordance are novel and provide important information on how the care of chronic conditions interacts with diabetes care. There are several strengths

to our study. To date, no study has analyzed as large or comprehensive a set of diabetes care goals and chronic conditions.[43,80,97,98,127] Previous studies on diabetes concordance or discordance have used authors' opinions [43,97,98,127,128] or the nominal group technique. [80] In contrast, the Delphi Method mitigates undue influence from other members of the group, as respondents do not know the individual responses of other group members. Our approach employed the professional judgment of PCPs who are experts at managing and coordinating the care of multimorbid patients. As the front-line providers for these complex patients, their opinions on care are most relevant for study, resulting in findings that are highly applicable to everyday clinical practice. Compared to published clinical practice guidelines, which are single-condition based and often written for specialty practice, a survey of PCPs shows the complex cognitive and clinical realities of caring for multimorbid patients with diabetes.[23]

Validation of prior work and increased depth of the number of conditions are key contributions of this work for future clinical and research use. As a validity check, we compared the summary-level condition results to previous literature on the subject.[129] Our results were generally consistent with the limited categorizations in prior literature, and added previously uncategorized conditions. See Table 3 for this comparison.

Our study also reframes concordance and discordance from solely summary-level to both goal-level and summary-level. This expanded knowledge can be used to understand the interrelatedness of conditions in more detail than can be done with only summary-level concordance and discordance.[49] Of the 50 summary-level discordant

conditions, 19 were concordant with diabetes on 1-2 individual diabetes care goals. Although discordant on the summary-level, these conditions still have the potential to interact synergistically with diabetes for those care goals with which they are concordant. These conditions could therefore improve diabetes care for these goals while distracting from diabetes care for other goals.

Six of the concordant conditions were concordant with diabetes on all goals, except the annual eye exam which was only concordant for a single condition, degenerative eye disease. Clinically, this cluster of conditions comprises atherosclerotic vascular conditions and renal disease, conditions that share pathophysiology with diabetes and co-occur frequently. The remaining concordant conditions are related to the vascular system and/or metabolic syndrome. All concordant conditions have goal-level concordance with diabetes for LDL and blood pressure management, highlighting the importance of cardiovascular risk management for both diabetes and to provide synergistic benefit to common comorbidities.

As up to 60% of patients with diabetes have comorbid hypertension,[130] it is notable that the presence of hypertension, a concordant condition, may improve achievement of management and treatment diabetes goals including blood pressure control. [104] When meeting a diabetes care goal also meets a care goal for another condition, patients and providers may more readily focus on that goal despite perceived barriers of complex treatment regimens. For example, it is likely that a provider and patient will have more urgency to achieve the care goal of blood pressure control when the patient has multiple

conditions that require addressing the same care goal and when not doing so could increase the patient's overall cardiovascular risk.

Interestingly, there was some discrepancy between PCP perceptions and guideline recommended care, which may reflect lower familiarity with less commonly seen conditions. The discrepancy also highlights a tremendous opportunity to correct mental models for concordant conditions to heighten care for patients whose comorbidities may confer additive risk. For example, PCPs perceived lupus and rheumatoid arthritis (RA) as discordant with diabetes on the summary level, as well as on the goal level with blood pressure and lipid management. However, both lupus and RA increase cardiovascular disease risk, and guidelines for both conditions call for heightened attention to blood pressure, lipid control, and glycemic control.[131,132] Our current results align with results of prior work by our group showing that Medicare patients with RA and diabetes actually received fewer A1c tests than diabetes patients without RA,[133] fitting with provider perceived discordance despite shared physiologic CVD risk.

A potential limitation of our study is that our expert panel included a variety of PCPs. While it is possible that the different specialties of the providers could bias our results, we think it is more likely that the diversity of our panelists best represents the range of PCPs and their opinions. We also chose certain diabetes care goals based on current guidelines and publicly reported quality metrics, but there are other care goals that are relevant to diabetes. However, the goals we studied are the most relevant to diabetes care in today's clinical environment.

Conclusions

Our study shows that PCPs perceive the care of diabetes to overlap with the care of several other chronic conditions, especially chronic conditions with well-known cardiovascular risks. We also found, however, that PCPs less strongly associated lupus and RA with cardiovascular risk management and therefore saw less overlap between these conditions and diabetes care. As our approach differentiates between summary-level and goal-level concordance and discordance, we are able to see potential helpful overlaps in care that are lost with summary-level only concordance. This knowledge will be especially useful as we move towards guidelines that focus on multiple chronic conditions and their interactions, rather than considering each condition in isolation. A major goal in health services research is to identify patient and system details associated with suboptimal care in order to target interventions to improve care. Understanding concordance and discordance on a goal-level could be key to identifying patients with diabetes most at-risk for suboptimal care due to their other chronic conditions, and to devising system-level interventions to target these patients. Additionally, clinical practice guidelines, and the quality reporting metrics based on these guidelines, can be modified to incorporate an understanding of the differing degrees in overlap of care between diabetes and other chronic conditions in complex patients. Future research can be done with these results to assess the impact of concordant and discordant conditions on diabetes clinical care and outcomes.

Table 1. Summary-level concordant and discordant conditions	
CONCORDANT CONDITIONS	
Cardiac, vascular, and pulmonary conditions Acute myocardial infarction in past 2 years Cardiomyopathy and structural heart disease Cerebrovascular disease Congestive heart failure Coronary atherosclerosis Hyperlipidemia Hypertension Peripheral atherosclerosis Thrombosis and Embolism	**Genitourinary and reproductive conditions** Chronic renal failure Polycystic ovarian syndrome **Other conditions** Obesity
DISCORDANT CONDITIONS	
Cardiac, vascular and pulmonary conditions Aneurysm Asthma or chronic obstructive pulmonary disease Conduction disorder or cardiac dysrhythmia Congenital heart disease Heart valve disorder Non-thrombotic, non-athlerosclerotic vascular disease Pulmonary heart disease **Genitourinary and Reproductive Conditions** Benign prostatic hypertrophy (BPH) Female infertility and GU anatomic disorders (e.g., prolapse, endometriosis) Kidney and Vesicoureteral Disorders (excluding renal failure) Menopause and Perimenopause **Musculoskeletal conditions** Back problem Gout or other crystal arthropathy Osteoarthritis **Neurologic Conditions** Epilepsy Migraines Multiple sclerosis Organic brain problem (dementia) Other central and peripheral nervous system disorders Paralysis Parkinson's disease **Other conditions** Amyloidosis Chronic skin ulcer Cystic fibrosis Degenerative eye problem Non-cardiac congenital disorder Sarcoidosis	**Hematologic and Oncologic Conditions** Anemia Malignant neoplasm Sickle cell anemia **Allergy and immunity conditions** Allergic rhinitis Immunity disorder Lupus Human immunodeficiency virus Rheumatoid arthritis Tuberculosis **Gastrointestinal Conditions** Chronic liver disease (excluding chronic hepatitis) Chronic hepatitis Chronic pancreatitis Diverticulosis, diverticulitis, enterocolitis, intestinal malabsorption Esophageal disorder **Mental Health Conditions** Anxiety disorders Behavior disorders Bipolar disorder Depression and depressive disorders Personality disorder Schizophrenia and psychotic disorders Sleep disorders Substance-use disorders **Endocrine conditions** Thyroid disorder

Table 2. Goal-level concordant and discordant conditions	
CONCORDANT CONDITIONS	
Concordant on all goals except eye exam	**Concordant on all goals except kidney function monitoring and annual eye exam**
Acute myocardial infarction in past 2 years	Hyperlipidemia
Coronary atherosclerosis	Polycystic ovarian syndrome
Peripheral atherosclerosis	Obesity
Hypertension	
Cerebrovascular disease	
Chronic renal failure	
Concordant on all goals except annual eye exam and blood sugar management	
Congestive heart failure	
Cardiomyopathy and structural heart disease	
Thrombosis and embolism	
DISCORDANT CONDITIONS	
Discordant on all goals	**Discordant on all goals except blood pressure management**
Asthma or COPD	Conduction disorder or cardiac dysrhythmia
Chronic hepatitis	Congenital heart disease
Diverticulosis, diverticulitis, enterocolitis, intestinal malabsorption	Chronic liver disease (excluding chronic hepatitis)
Esophageal disorder	Menopause and perimenopause
Chronic pancreatitis	Paralysis
Female infertility/GU anatomic disorders	Migraines
Benign prostatic hypertrophy (BPH)	Organic brain problem (dementia)
Epilepsy	Other central and peripheral nervous system disorders
Multiple sclerosis	Sleep disorders
Parkinson's disease	
Back problem	**Discordant on all goals except kidney function monitoring**
Osteoarthritis	Gout or other crystal arthropathy
Anemia	Sickle cell anemia
Malignant neoplasm	Rheumatoid arthritis
Allergic rhinitis	
Immunity disorder	**Discordant on all goals except annual eye exam**
Tuberculosis	Degenerative eye problem
Human immunodeficiency virus	
Anxiety disorders	**Discordant on all goals except blood pressure management and kidney function monitoring**
Depression	Heart valve disorder
Bipolar disorder	Aneurysm
Substance-use disorder	Non-thrombotic, non-atherosclerotic vascular

	disease
Personality & psychogenic disorders	Pulmonary heart disease
Schizophrenia and psychotic disorders (excluding mood disorders)	
Behavioral disorders	**Discordant on all goals except blood pressure management and kidney function monitoring**
Chronic skin ulcer	Kidney and vesicoureteral disorders (excluding renal failure)
Thyroid disorder	Lupus
Amyloidosis	
Sarcoidosis	
Cystic Fibrosis	
Non-cardiac congenital anomaly	

Table 3. Comparison of Our Findings to Previous Work

We newly categorized 17 conditions not previously categorized as concordant or discordant (13 as discordant, 4 as concordant), and confirmed concordance or discordance of other conditions. Our results did not conflict with any previous work.

Concordant Conditions		**Discordant Conditions**	
Confirmed Concordant	**Newly Found to be Concordant**	**Confirmed Discordant**	**Newly Found to be Discordant**
acute myocardial infarction	cardiomyopathy	osteoarthritis	heart valve disorder
congestive heart failure	thrombosis and embolism	back problem/pain	aneurysm
coronary atherosclerosis	obesity	mental illness	non-thrombotic, non-atherosclerotic vascular disease
peripheral atherosclerosis	polycystic ovarian syndrome	GERD	benign prostatic hypertrophy
hypertension		irritable bowel syndrome	female infertility and genitourinary anatomic disorders
cerebrovascular disease		hepatitis	sickle cell anemia
chronic renal failure		chronic obstructive pulmonary heart disease	immunity disorder
		multiple sclerosis	tuberculosis
			thyroid disorder
			amyloidosis
			sarcoidosis
			cystic fibrosis

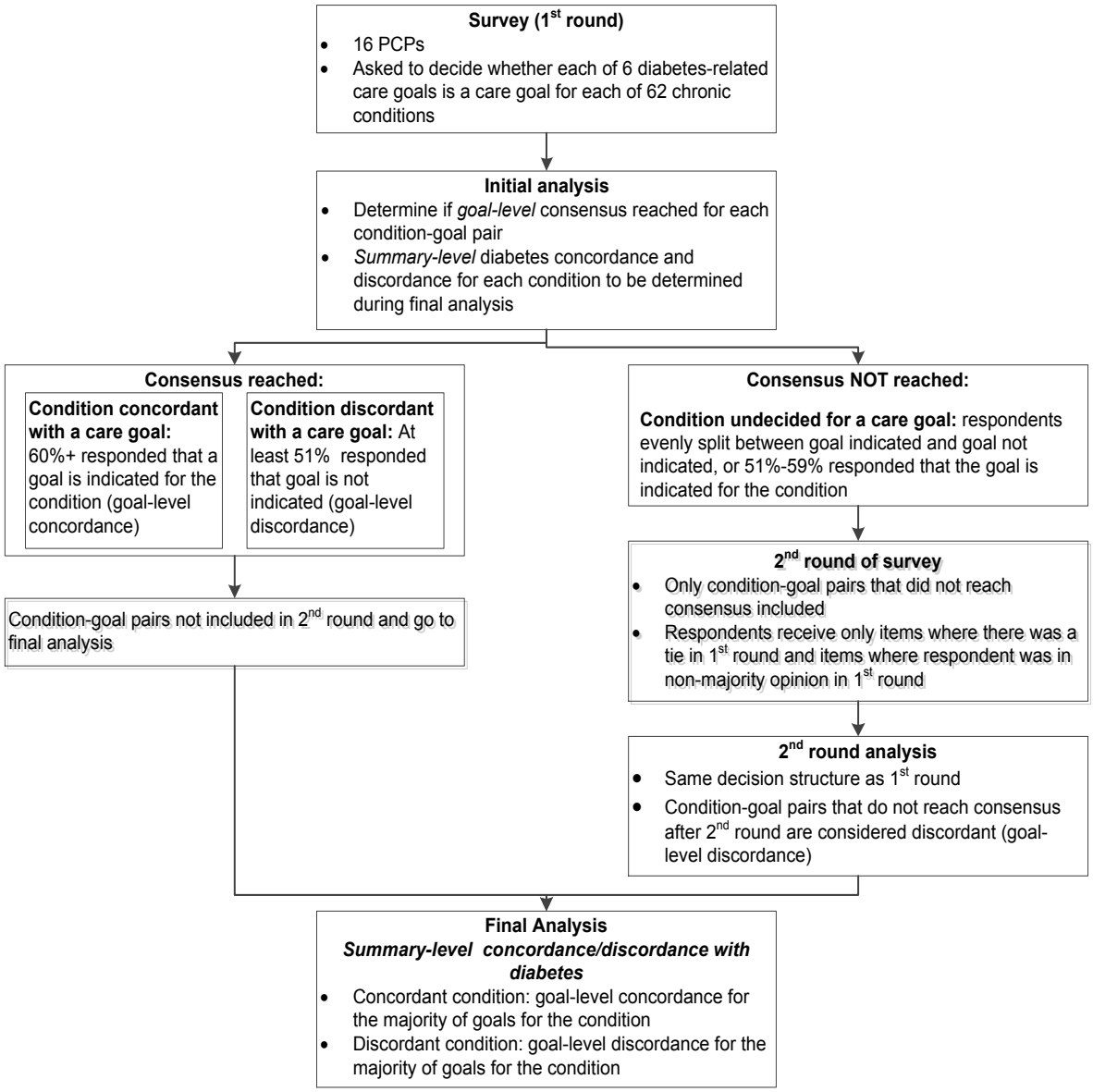

Figure 1. Establishing chronic conditions' goal- and summary-level concordance and discordance with diabetes

CHAPTER 7. PAPER 2: THE IMPACT OF A PATIENT'S CONCORDANT AND DISCORDANT CHRONIC CONDITIONS ON DIABETES CARE QUALITY MEASURES

Abstract

Aims: Most patients with diabetes have comorbid chronic conditions that can support or compete with diabetes care needs. We sought to determine the impact of chronic conditions with concordant or discordant management 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.

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

Conclusions: Concordant conditions make diabetes care goal achievement more likely, with a larger impact for testing than control. Discordant conditions had little impact on diabetes goal achievement. Interventions to improve diabetes care need to align with a patient's individual comorbidities, including the absence of concordant conditions.

Introduction

21 million people in the US have diabetes and at least one other chronic condition, which has critical implications for the health outcomes of this growing population. [6] Despite the high prevalence and negative health effects of diabetes, its management remains suboptimal, with less than half of patients achieving goal blood pressure control and less than two thirds achieving glycemic control.[12] One of the challenges for improving diabetes care is that providers and patients face multiple competing demands in the management of diabetes and other chronic conditions, with no clear guidance on prioritization of care or how multiple chronic conditions effect care. [23,42] Guidelines suggest providers spend 11 hours/day on chronic condition management and patients spend 143 minutes/day on diabetes self-care and take 19 medications for diabetes plus four co-morbid conditions. [32,73,134] These guidelines do not support providers in integrating multiple care needs of diabetes and co-morbid chronic conditions. [32,49] Additionally, current public reporting and pay for performance measures do not consider the effects of multiple chronic conditions on diabetes outcomes. [135] We are unable to improve guidelines, public reporting and interventions for patients with diabetes and multimorbidity without better understanding how multimorbidity impact diabetes care quality, and how to describe and quantify multimorbidity. [136]

The care of patients with diabetes who have other chronic conditions can involve concordant (similar) or discordant (dissimilar) management of the co-morbid conditions. The care of these co-morbidities can either support or compete with diabetes care as described in the Piette and Kerr's conceptual framework of Concordance and

Discordance[42] using elements of the model of Competing Demands. [66] This framework suggests that patients with more concordant conditions will receive better diabetes care due to provider cuing and synergistic care,[42] while patients with more discordant conditions will receive worse diabetes care due to distraction and competition for limited resources.[66] 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. There is conflicting evidence that the presence of concordant and discordant conditions leads to differences in the receipt of recommended care.[43,75,80,98,99,101-103,137] For example, concordant conditions have been associated with a higher likelihood of HgbA1c and LDL cholesterol control in one study [97] but only with cholesterol control in another,[80], and discordant conditions were associated with both better and worse diabetes care.[80,97,100] However, these studies used limited lists of chronic conditions (the majority under 10), and none assessed the role of both the number and combination of concordant and discordant chronic conditions on diabetes care goal achievement. Understanding if and how the number of concordant and discordant conditions influences diabetes care will provide a method to define multimorbidity, beyond a total count of conditions as is often done,[43,138] to allow for the tailoring of interventions to improve diabetes care in patients especially at risk for poor care due to their multimorbidity profiles.

The purpose of our study was to understand the effect 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.

Methods

Sample: Adult patients (aged 18-75) with diabetes 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), were included. 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.[61,139] 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. [61] Two years of electronic health record data were used, a baseline year, 2010, and a quality metrics reporting year, 2011. The presence of diabetes (any type) 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.[61] A patient has a medical home at the provider group if they had at least two E&M office visits to a primary care provider (or one E&M visit to a primary care provider and one to an endocrinologist), regardless of diagnostic codes, on different dates of service in the past two years and were eligible for the study if they were seen at least once for an ambulatory care visit in the reporting year, 2011.[61] The Minimal Risk Health Sciences

Institutional Review Board at the University of Wisconsin determined the project was exempt from IRB oversight.

Outcome Variables: We used American Diabetes Association guideline-recommended diabetes testing and control care goals for adult patients aged 18-75 that are shown to be associated with macrovascular and microvascular outcomes as our outcome variables, with 2011 goal levels (reporting year).[61,140] 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.[61,140] We also used two overall measures of diabetes control, "all testing" (all 3 testing goals achieved) and "all control" (all 3 control goals achieved). Variables were binary (goal achieved or not).

Explanatory Variables: The number of concordant conditions and the number of discordant conditions in each patient's comorbidity profiles 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.[19,138] We used a comprehensive set of 62 chronic conditions (excluding diabetes) based on an established list of outpatient-relevant chronic conditions (ICD-9 codes) developed from the AHRQ Clinical Classification Software (CCS) categories.[30,31] This chronic condition set combines similar chronic conditions, such as "diabetes" and "uncontrolled diabetes"

into the same chronic condition categories, based on CCS categories, so that the 62 "chronic conditions" used in this paper cover 1,412 ICD-9 codes. Chronic conditions were assessed in the baseline year, 2010, to ensure they were active and present before the quality reporting time frame. Chronic conditions were then categorized as concordant or discordant to diabetes based on primary care expert for diabetes-similar or dissimilar care, as per Piette and Kerr's conceptual framework.[42] Of 62 conditions, 12 were considered concordant and 50 were considered discordant (Supplementary Table).

Covariates: All models were adjusted for a comprehensive set of patient socio-demographic and health care utilization factors. Socio-demographic factors included age, gender, race (white or other), insurance (non-commercial Medicare, Medicaid, commercial (including commercial Medicare), or self-pay/unreported), patient ever on Medicaid, number of face-to-face E&M office visits (in baseline year, 4 level categorical variable)[61,141] and an indicator for health system. 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's County Health Rankings.[142] We determined additional proxy measures of socioeconomic status by linking patient zip codes to census tract data for the percent of population in the patient's zip code below the poverty line, and without a high school education. We also

included rural-urban commuting area codes based on the patient's zip code (RUCA, 4 level).[143]

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 relation 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 examine the effect of concordance and discordance, versus total number of conditions, we compared the coefficients of concordant conditions to those of discordant conditions using Wald tests and found that the two were significantly different. Hence, we concluded numbers of concordant and discordant conditions should be used in our models rather than the total number of

comorbid conditions. Our final models had the number of concordant conditions and discordant conditions as categorical variables with 0-1 conditions (reference), 2-3 conditions, and 4+ conditions as the categories. An interaction term between the number of concordant and the number of discordant conditions was tested to assess the extent to which the relationship between concordant conditions and diabetes care quality differed for patients with different numbers of discordant conditions (the mix of concordance and discordance). This was found not to improve prediction by BIC or c-statistic.

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. Receipt of LDL 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 greater number of concordant conditions, adjusted for patient socio-demographics and health care utilization characteristics. Patients with 2 or more concordant conditions had greater odds of diabetes testing goal achievement (HbA1c, cholesterol, kidney testing, and all testing) than patients with 0-1 concordant conditions, regardless of the number of discordant conditions (Table 3), though the greatest difference was demonstrated for patients with 4+ concordant conditions as compared to 0-1 concordant conditions. At the highest level of discordance, 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 was associated with only a minimally higher 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]). The number of discordant conditions had no significant effect on kidney or all testing goal achievement.

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]). Discordant conditions were associated with minimally but statistically significant higher odds of achieving HbA1c control and blood pressure control with 2+ discordant conditions compared to 0-1 discordant conditions,

and of achieving all control with 4+ discordant conditions. Discordant conditions had no impact on cholesterol control.

Discussion

We found that having 2 or more concordant conditions is associated with better diabetes care quality for testing and control goals. The patients with the fewest concordant conditions had the lowest likelihood of achieving diabetes care goals. The impact of concordant conditions was strongest for testing goals, and was more important than the impact of discordant conditions on diabetes goal achievement. We found no effect or minimal supportive effect of having discordant conditions, except for cholesterol testing where there was a small but significant detrimental effect of discordance. Discordant conditions were associated with slightly more HbA1c testing, and higher achievement of control goals, with the exception of cholesterol control, even after controlling for the number of other outpatient visits. The mix of concordance and discordance did not affect diabetes care goal achievement beyond that seen for the number of concordant and discordant conditions. Our results partially support the Concordance and Discordance framework in that we found that patients with more concordant conditions received better diabetes care but we did not show that patients with more discordant conditions received substantially worse diabetes care.

Our results are consistent with literature showing that concordant conditions improve diabetes management in the setting of multiple chronic conditions.[80,96,104,137] 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.[80] 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.[137] The reason for higher diabetes goal achievement with concordant comorbidities fits prior 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.[42,43,80]

Another consideration is that patients with concordant conditions might receive better diabetes care due to a greater sense of urgency in the clinician, and in the patient, to optimize diabetes care when patients already have diabetic complications and have a greater need for diabetes care goal achievement.[43,82,98,140] In one study, providers only intensified blood sugar treatment in uncontrolled diabetes for patients who had a new-onset complication. [98] In another study, patients with microvascular-concordant conditions express higher self-care priority placed on diabetes care goals than patients without these concordant conditions.[43]

Contrary to what we expected, discordant conditions were not associated with worse care in our study, with the exception of less cholesterol testing. In their concordance-discordance framework, Piette and Kerr focused on discordant conditions diverting resources from diabetes care[42] rather than the potential beneficial effect of concordant

conditions, and their subsequent research has focused on the reduction in care seen with discordance. [80] In contrast, we found a slight beneficial effect from discordant conditions for HbA1c testing and for 3 of the 4 control goals, even after controlling for number of visits. A previous study showed that patients with only discordant conditions were less likely to achieve HbA1c and cholesterol testing and control goals than patients with no comorbid conditions.[80] However, this study considered patients with any number of discordant conditions as being equal to each other, and also removed patients with serious or terminal discordant conditions (*e.g.* cancers, end stage renal disease). Our approach allowed examination of the impact of the number of discordant conditions for 50 discordant conditions, giving granular detail to our assessment of the impact of discordance on diabetes care.

The model of Competing Demands would suggest that discordance should distract providers from ordering tests;[42,66] however it is plausible that test ordering is robust to distraction as providers can order lab tests easily. We found that discordant conditions did not distract from HbA1c and kidney tests, while 4+ discordant conditions reduced the likelihood that LDL cholesterol testing was completed. Patients can complete HbA1c and kidney testing the day of a clinical visit, but the LDL cholesterol test requires fasting and often a return visit. This suggests that discordance can be detrimental when the task is complex enough, as when it cannot be completed at the current visit or requires fasting, or the discordance 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.

Control goals might be considered more complicated to achieve than testing goals, as they are influenced by a combination of medications and patient lifestyle, and require provider prescribing, counseling and coordinated follow-up. This combination of factors might suggest that achievement of control is more susceptible to competing demands on the patients' time from discordant conditions. However, we found that discordance slightly improved achievement of control goals. This could be due to patients with more conditions having a perceived need for more care.[17,19] Also, although discordant conditions have been associated with lower patient-perceived self-management ability and self-care priority for diabetes over other conditions,[43] medication and lifestyle changes for discordant conditions could still benefit diabetes control goals.

Blood pressure control was the least achieved single goal in our study, and the only goal less likely to be achieved with increased concordance. Additionally, having 2 or more discordant conditions was associated with a minimally higher likelihood of achieving blood pressure control. Although blood pressure control is a top priority in diabetes care,[140] it is multifactorial and the average patient needs 2-3 antihypertensive medications to achieve control, requiring appropriate medication titration and timely follow-up.[144] Lastly, having certain concordant complications of diabetes (*e.g.* nephropathy) can contribute to difficult-to-control or resistant hypertension.[145]

Major strengths of this study include a large sample of patients with diabetes (n=24,430) from 7 health systems with standardized diabetes metrics reporting algorithms.[61] We

identified 62 different concordant and discordant chronic conditions in these patients. The concordance or discordance of these conditions was defined in a separate study by consensus of expert opinions of primary care providers, a difference from concordance-discordance determination in previous studies.[43,80,96] We also assessed the impact of the number of concordant and discordant conditions to determine the impact of the amount of concordance in a patient's comorbidity profile, rather than using an any vs. none approach.[80,96] We identified each patient's concordant and discordant conditions as conditions that were evaluated at an office visit in the baseline year to ensure that the conditions were being actively managed and had the opportunity to support or distract from diabetes care, rather than including historic conditions that might not be currently managed. We chose to control for number of office visits in the baseline year. While number of office visits might be in the causal pathway between number of comorbid conditions and quality of care, the goal of this study was to focus on the impact of the concordance and discordance of conditions, above and beyond any effect from number of visits. In a previous study, the detrimental effect of discordance disappeared when a patient had more than 24 office visits in a year.[80] After controlling for office visits, we found that the direction and significance of the odds ratios did not change, suggesting much of the impact of concordance and discordance has 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.[61] Diabetes quality achievement was

similar to achievement found in a national public reporting sample, with less HgbA1c testing and more blood pressure and cholesterol control achievement.[12] 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. Additionally, although used frequently in public reporting, our outcomes, the achievement of testing and control goals, 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 [61,141] that might influence care goal achievement, although we found adjusting for number of visits minimally changed our results. We were also unable to control for the duration of diabetes or of the comorbid conditions. Finally, we did not test the effect of specific individual chronic conditions or severity of those conditions on diabetes outcomes, but rather the number of concordant and discordant conditions. The goal of this paper was to assess the role of concordance and discordance in diabetes care, and determine if this framework can be useful to build comorbidity indices.[42 138] Future work could examine the impact of individual concordant and discordant conditions. 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.[133]

Conclusions

In our time-constrained environment, understanding the influence of comorbidities and how to prioritize care considering multiple competing demands is especially important.[42,66,80] As current clinical guidelines suggest a total of 22 hours/day of care per provider to manage chronic, acute and preventive care,[73,74] to provide adequate care we must consider the interaction and prioritization of care goals for those with multiple care needs as is especially burdensome in multimorbidity.[23,49] Guidelines and new, systematic approaches to chronic condition care management should address where care is concordant to provide efficient, synergistic care to reduce complications, and to target patients who are less likely to receive recommended diabetes care due to lack of concordance.

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 [61,140]

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

Supplementary Table: Chronic Conditions, categorized as Concordant or Discordant with Diabetes

CONCORDANT CONDITIONS

Cardiac, Vascular, and Pulmonary Conditions
- Myocardial infarction in past 2 years
- Cardiomyopathy and structural heart disease
- Cerebrovascular disease
- Congestive heart failure
- Coronary atherosclerosis
- Hyperlipidemia
- Hypertension
- Peripheral atherosclerosis
- Thrombosis and embolism

Genitourinary and Reproductive Conditions
- Renal failure
- Polycystic ovarian syndrome

Other Conditions
- Obesity

DISCORDANT CONDITIONS

Cardiac, Vascular and Pulmonary Conditions
- Aneurysm
- Asthma or chronic obstructive pulmonary disease
- Conduction disorder or cardiac dysrhythmia
- Congenital heart disease
- Heart valve disorder
- Non-thrombotic, non-atherosclerotic vascular disease
- Pulmonary heart disease

Genitourinary and Reproductive Conditions
- Benign prostatic hypertrophy (BPH)
- Female GU disorders
- Kidney and Vesicoureteral Disorders
- Menopause and Perimenopause

Allergy and Immunity Conditions
- Allergic rhinitis
- Immunity disorder
- Lupus
- Human immunodeficiency virus
- Rheumatoid arthritis
- Tuberculosis

Neurologic Conditions
- Epilepsy
- Migraines
- Multiple sclerosis

Gastrointestinal Conditions
- Liver disease
- Hepatitis
- Pancreatitis
- Non-Infectious intestinal disorders
- Esophageal disorder

Mental Health Conditions
- Anxiety disorders
- Behavior disorders
- Bipolar disorder
- Depression and depressive disorders
- Personality disorder
- Schizophrenia and psychotic disorders
- Sleep disorders
- Substance-use disorders

Hematologic and Oncologic Conditions
- Anemia
- Malignant neoplasm
- Sickle cell anemia

Musculoskeletal Conditions
- Back problem
- Crystal arthropathies
- Osteoarthritis

Organic brain problem (dementia)	Other Conditions
Other central and peripheral nervous system disorders	Amyloidosis
Paralysis	Chronic skin ulcer
Parkinson's disease	Cystic fibrosis
	Degenerative eye problem
Endocrine Conditions	Non-cardiac congenital disorder
Thyroid disorder	Sarcoidosis

CHAPTER 8. PAPER 3: THE RELATIONSHIP OF INDIVIDUAL COMORBID CHRONIC CONDITIONS TO DIABETES CARE QUALITY

Abstract

Background: Multimorbidity affects 26 million persons with diabetes, and care for comorbid chronic conditions may impact diabetes care quality.

Objective: To determine which chronic conditions were related to suboptimal or optimal diabetes care quality.

Design: Retrospective analysis of electronic heath record data.

Setting: Seven Midwestern health systems that participate in quality reporting.

Patients: 24,430 adults, aged 18-75, with diabetes.

Measurements: The main outcome measures were achievement of 6 diabetes control and testing care goals in the reporting year. Explanatory variables were 62 chronic condition indicators. Analyses were adjusted for baseline patient socio-demographic and health care utilization factors.

Results: The 62 chronic conditions varied in their relationships to diabetes care goal achievement for specific care goals. Of the 17 conditions related to suboptimal care (control, testing or both), 6 were related to suboptimal care for more than one goal, including congestive heart failure, substance-abuse, depression and obesity. Hyperlipidemia and coronary atherosclerosis are among 23 conditions related to optimal

HbA1c control, and among 10 related to optimal LDL or BP control. Nine conditions were related to suboptimal cholesterol testing, including congestive heart failure and depression. One third of the comorbid conditions did not predict diabetes control or testing.

Limitations: Large Midwestern population; retrospective cohort design limits causal inference.

Conclusions: Future interventions should integrate multimorbidity care goals and focus on self-care for patients with comorbid conditions related to suboptimal care for more than one care goal.

Introduction

Over half of individuals in the US have at least one chronic condition, and almost one third have multimorbidity, the presence of two or more co-occurring chronic conditions.[2] Diabetes is an extremely common chronic condition, occurring in 10% of U.S. adults.[2] Over 83% of these individuals, 26 million adults, have multimorbidity.[7] The quality of care for patients with diabetes who have multimorbid diabetes is suboptimal.[7,16] The US Department of Health and Human Services, The Institute of Medicine, the Patient-Centered Outcome Research Institute, and others have recognized the need to integrate and prioritize care across multiple conditions and patient preferences.[21,36,51,67] A recent Cochrane review on multimorbidity interventions demonstrated the paucity of studies for patients with multimorbidity, with no interventions for multimorbidity that includes diabetes except one for patients with both diabetes and depression.[94] Without care approaches that take into account patients' multimorbidity, both clinicians and patients are left solely managing a person's diabetes, rather than managing the total health care of a person with diabetes.

One reason for the limited number of interventions may be that the relationship of individual comorbid chronic conditions to diabetes quality is not known.[21] Diabetes care quality is measured as the achievement of diabetes care goals, including HbA1c testing and level of control, LDL cholesterol testing and level of control, kidney testing and blood pressure control.[61,139,140] A conceptual model suggests the relationship between multimorbidity and diabetes care quality is due to characteristics of the multimorbid conditions, such as whether the condition shares management goals with diabetes or

not (e.g., hyperlipidemia vs. depression), or is clinically severe or not (e.g. heart failure vs. obesity) or is symptomatic or not (e.g. anxiety vs. hypertension).[42] Some studies suggest that comorbidities can support optimal diabetes care if they share care goals and distract from diabetes care if they do not, or if the comorbidities are clinically severe.[42,43,80] However, other work has shown no effect from comorbid conditions that don't share care.[98] A potential limitation of these studies is that they considered all conditions within the same type (*i.e.*, share care goals, don't share care goals, or are clinically severe) as equivalent when determining impact on diabetes care. However, in actuality, some conditions might have a greater or lesser impact on diabetes testing and control goal achievement. This impact could be due to a combination of factors, such as sharing care goals, clinical severity, symptoms, and patient and provider preference for care.[42,43,82] Only a few specific conditions, such as hypertension and depression,[24,146,147] have been assessed for their individual impact on the achievement of diabetes care goals, and even then for a limited set of care goals. As diabetes care quality consists of achieving multiple care goals, including both testing and control goals, individual conditions could have a different relationship with diabetes care for each care goal. It is critical to determine which specific comorbid conditions are related to achievement (or lack of achievement) of specific diabetes care goals to inform interventions for diabetes in the context of multimorbidity that can help providers and patients integrate and prioritize multiple competing care needs.[49]

The objective of this study was to determine the relationship between specific co-morbid conditions and the achievement of diabetes quality care goals. We hypothesized that

the relationship between the condition and the achievement of diabetes care goals would vary for each condition and care goal, with either optimal care (positive association with achievement), suboptimal care (negative association with achievement) or no relationship with care (no association).

Methods

Design and Setting

We conducted a retrospective analysis of two years of electronic health data, 2010 (baseline year) and 2011 (quality reporting year), for 7 health systems that participate in a Midwestern quality reporting collaborative, the Wisconsin Collaborative for Healthcare Quality. The health systems are academic and community practices in rural, suburban, and urban settings. The Minimal Risk Health Sciences Institutional Review Board at the University of Wisconsin determined the project was exempt from oversight.

Patients

Eligible patients had a diagnosis of diabetes, were 18-75 years old, and were medically homed within the 7 participating health systems.[61] We focused on patients eligible for public reporting of diabetes quality care metrics to ensure general consensus about the definition of optimal and suboptimal diabetes quality. Diabetes was defined by at least two face-to-face ambulatory visits (using CPT-4 outpatient evaluation and management codes) with any clinician with an ICD-9 diagnosis code of 250.XX, 357.2, 362.XX, 366.41, or 648.XX on different dates of service over the two years of data.[61] Medically homed was defined as at least two face-to-face office visits to the group on different

dates of service in the past two years, with at least one for an ambulatory care visit in the reporting year.[61]

Primary Outcome Variables

Our primary outcome variables were the achievement of 3 control and 3 testing diabetes care goals, recommended in clinical guidelines, used in public reporting, and shown to be associated with macrovascular and microvascular outcomes in diabetes.[61,140] Variables were binary, representing goal achievement (optimal care) or not (suboptimal care) in the reporting year. There were 3 control goals: HbA1c control <7% (or <8% if 65-75 years old or having specific comorbidities)[61,139]; LDL cholesterol control <100 mg/dL; blood pressure (BP) control at <130/80 mmHg. There were also 3 testing goals: HbA1c testing two or more times; LDL cholesterol testing; kidney function testing by either a urine microalbumin test or documented evidence of nephropathy.[61,140] Documented evidence of nephropathy included a visit to a nephrologist for any reason, a diagnosis code for chronic kidney disease or renal manifestations of diabetes, or evidence of dialysis treatment during the reporting year.[61]

Main Explanatory Variables

Indicator variables for patient comorbidities were the main explanatory variables. We used a comprehensive set of 62 chronic condition indicators (excluding diabetes) based on an established list of outpatient-relevant chronic conditions developed from the AHRQ Clinical Classification Software (CCS) categories.[30,31] The 62 chronic condition indicators cover 1,412 ICD-9 codes. Chronic conditions were defined as those billed at

a face-to-face visit in the baseline year to ensure they were active and present before the quality reporting time frame. See Appendix Table for a list of the 62 conditions organized by body system.

Covariates

We defined variables for patient socio-demographic characteristics and health care utilization. Socio-demographic characteristics were age, gender, race (white or other), insurance (non-commercial Medicare, Medicaid, commercial (including commercial Medicare), or self-pay/unreported), patient ever on Medicaid, number of face-to-face office visits in the baseline year (coded as 4 categories)[61,141] and an indicator for health system. To account for potential 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 Johnsons County Health Rankings.[142] We also determined rural-urban commuting area codes based on each patient's zip code (RUCA, 4 level).[143] We defined two additional socioeconomic status proxy variables by linking patient zip codes to census tract data. The variables represent the percent of the population in the patient's zip code who live below the poverty line and who do not have a high school education.

Statistical Analyses

All analyses were conducted using Stata 13.0 (Stata-Corp, College Station, TX). Descriptive analyses summarized categorical variables using percentages and continuous variables using means with standard deviations. Logistic regression model were fit for each of the 6 recommended diabetes control and testing goals, to assess the relationship between the 62 individual chronic conditions and the achievement of goal, adjusted for covariates as described above. Results are reported as odds ratios (OR) and 95% confidence intervals (CIs). The significance of each condition on diabetes goal achievement was determined at $p<0.05$. Initial models included all 62 conditions together. Final models for the 3 testing goals included conditions that were significant for at least 1 testing goal (*i.e.*, 3 models and each model had a different outcome variable and the same explanatory variables). Final models for the 3 control goals included conditions that were significant for at least 1 control goal.

Results

Patient characteristics

Our sample had 23,430 patients with diabetes, between the ages of 18-75 (Table 1). Patients had 0-22 co-morbid conditions, with an average of 3.8 (SD=2.5).The frequencies of all 62 chronic conditions ranged from 77% for hyperlipidemia to 0.01% for tuberculosis (Supplementary Table).

Relationship of Individual Chronic Conditions to Diabetes Control

After controlling for patient socio-demographic factors and number of office visits, 12 conditions predicted suboptimal diabetes control (Table 2). Of these conditions, 5 were related to suboptimal HbA1c control, including obesity and depression. Eight conditions were related to suboptimal cardiovascular risk reduction (LDL and/or BP control). These included: congestive heart failure (suboptimal LDL control but optimal BP control), hypertension (suboptimal BP control but optimal LDL control), obesity (suboptimal BP control), thrombosis and embolism (suboptimal LDL control), anxiety (suboptimal LDL control) and substance-abuse (suboptimal LDL and BP control).

Twenty-six conditions were related to optimal control. Hyperlipidemia and coronary atherosclerosis were related to optimal control for all 3 control goals. Nineteen additional conditions were related to optimal HbA1c control, alone or with optimal LDL or BP control.

Relationship of Individual Chronic Conditions to Diabetes Testing

All conditions, except hepatitis, that were related to suboptimal achievement of testing goals were related to suboptimal LDL testing (Table 3). These included: congestive heart failure, thrombosis and embolism, depression and substance-use disorders, and rheumatoid arthritis. Depression and substance-abuse were also related to suboptimal kidney and HbA1c testing, respectively.

Hyperlipidemia, hypertension, obesity and renal failure were among 7 conditions related to optimal HbA1c testing. Hyperlipidemia was related to optimal testing for all 3 testing goals. Renal failure had the strongest association for achievement of a testing goal for kidney testing with OR 29.1 (95% CI: 18.6-45.4); a diagnosis of renal failure meets the kidney testing metric by definition.

Conditions with No Relationship to Diabetes Control or Testing

Of 62 conditions, 21 were related to neither control nor testing, 7 additional conditions were not related to control but were related to testing, and 17 were not related to testing but were related to control (Table 4). These conditions span multiple organ systems and include stroke, cardiomyopathy and peripheral atherosclerosis.

Discussion

We found that, as expected, the 62 chronic conditions varied in their relationships to diabetes care goal achievement for specific care goals with some commonalities. Congestive heart failure, substance abuse and thrombosis were all related to both suboptimal control and testing for the same goal, LDL, while obesity was related to suboptimal control but optimal testing for the same goal, HbA1c. Mental health conditions were related to suboptimal care, but not for the same care goals. Hyperlipidemia and coronary atherosclerosis are among multiple conditions related to optimal HbA1c control, and among the fewer related to optimal LDL and/or BP control. Among conditions related to suboptimal testing, 9 of 10 were suboptimal for LDL testing. Finally, one third of the comorbid conditions had no relationship to diabetes care.

Congestive heart failure was related to both suboptimal LDL control and testing. This was surprising as LDL management is integral in heart failure care.[148] This same pattern of suboptimal LDL care was seen with substance-abuse and thrombosis and embolism. This suggests that LDL control might start with LDL testing. Interestingly, heart failure was also related to optimal control for one goal, BP control, which supports the theory that conditions that share diabetes care goals support their achievement, as blood pressure control is a specific care goal for heart failure,[42,148] and support a past study that showed blood pressure control was more important that cholesterol control to patients with diabetes.[86]

Obesity was related to suboptimal HbA1c control, as well as suboptimal BP control. However, obesity was also related to optimal HbA1c testing. The suboptimal control could be due to glucose and BP dysregulation in obesity, or lifestyle factors that worsen weight, HbA1c and BP control. The optimal testing with suboptimal control highlights the relative difficulty of achieving control compared to completing a non-fasting lab test. Control requires counseling at a visit and self-care, recommended 2 hours a day,[134] while ordering a lab test and completing it at the visit requires relatively minimal effort from the provider and patient.

Interestingly, while 3 mental health conditions were related to suboptimal diabetes care, they were not all suboptimal for the same goals. Depression was associated with suboptimal HbA1c control as well as suboptimal LDL and kidney testing. Substance-abuse was also suboptimal for LDL testing, as well as LDL control, BP control and

HbA1c testing. Anxiety, like substance abuse, was related to suboptimal LDL control, and, in contrast to depression, was related to optimal HbA1c control. Other mental health disorders were related to optimal care or had no relationship to care. Mental health conditions can present barriers to diabetes care through lack of motivation or an ability to perform self-care, [146,149] and our results suggest that these barriers vary by condition and by care goal.

Notably, the vast majority of conditions that were related to optimal control were optimal for HbA1c control (23 out of 26), while only 10 conditions were related to optimal control for cardiovascular goals (LDL and BP), including 2 conditions, hyperlipidemia and coronary atherosclerosis, that had optimal control for all 3 control goals. This is concerning as evidence shows cardiovascular risk reduction is more likely to reduce mortality in diabetes than glycemic control.[47,150] Also, several of the conditions that are related to optimal HbA1c control, but not cardiovascular risk reduction, aren't traditionally considered diabetes-related (e.g., osteoarthritis, cancer) and should be less likely to support HbA1c control.[42] These results may be at least partially explained by HbA1c control being prioritized over other care in diabetes, especially by patients.[86]

All conditions that were related to any suboptimal testing goal achievement were related to suboptimal LDL testing, except chronic hepatitis, which had low prevalence. One possible explanation for the suboptimal LDL testing is the lack of overlap in care goals that might lead to a lack of cuing providers to order the tests.[42] These conditions do not share the LDL testing goal with diabetes, except rheumatoid arthritis, where the

increased need for cardiovascular testing is less well known by primary care providers,[151] and congestive heart failure, which was also related to suboptimal LDL control. We have seen in prior work that patients with eye disease and diabetes are more likely to have eye exams,[90] supporting the framework that conditions that share care goals with diabetes serve as a reminder to complete the care.[42] Another possible explanation is that the LDL test is more challenging for patients to complete, compared to the HbA1c or kidney test, as it requires fasting and often a return visit. It could be that patients do not prioritize an inconvenient test for an asymptomatic condition over other needs.[42,43] Studies have shown that patients prioritize diabetes care over other care when they have with diabetes-related complications, but prioritize diabetes care less when they have non-diabetes related complications.[43]

Over half the conditions had no relationship to either testing or control goals, and one third had no relationship to any of the assessed care goals. Among these conditions are many that share diabetes care goals (e.g. stroke, peripheral atherosclerosis, cardiomyopathy) and could be expected to support goal achievement.[42] Many were conditions that can be symptomatic (e.g., back problems, migraines), and therefore could distract from diabetes care.[42] This finding suggests that overlap of goals with diabetes care, or potential for symptoms, are insufficient alone to determine if a comorbid condition will be related to optimal or suboptimal diabetes care. Patient and clinician priorities for condition management likely play a role, as do other patient socio-demographic and clinical characteristics (e.g. health literacy, functional status), and must also be considered in multimorbidity care.[36,82]

Strengths and Limitations

Major strengths of this study are the inclusion of a comprehensive set of 62 chronic conditions, 6 diabetes care goals, and a large sample across multiple health systems. We recognize that the sample is from one Midwest state and only includes health systems that participate in public reporting and this may limit generalizability. However, patients come from a wide range of ages, race/ethnicities, and payors, and diabetes care goal achievement was similar to results from a national sample in 2011.[12] Additionally, we note that the retrospective cohort design limits causal conclusions about the relationship between the presence of conditions and subsequent diabetes care goal achievement. We used ICD-9 codes billed at face-to-face visits in the baseline year to establish current, actively managed comorbid conditions, as has been used previously.[30,31] There is a risk for under-diagnosis of certain conditions with this approach, such as obesity [152] and depression [153]; however, this approach is not subject to the recall bias of self-report.[30] Our statistical approach included multiple variables, and many conditions were of low prevalence. We chose not to correct for multiple comparisons, such as with the Bonferroni method, to avoid increasing Type 2 error in this first-step study. Borderline significant results might no longer be significant after accounting for multiple comparisons. We recognize the low prevalence conditions are at a greater risk of Type 2 error, but feel this is acceptable in this initial study, as low prevalence comorbidities have a low impact on diabetes care at a population level, and these conditions can be explored in greater detail in future studies. We do recognize as well that conditions that were found not to be associated with diabetes care goals achievement might have an impact on diabetes care that cannot be detected in this

analysis due to low power. Also, while we included several socio-demographic variables, were unable to adjust for other factors, such as marital status, and used proxies for patient income and education. Finally, although we used only publicly reported testing and control care goals as markers of diabetes quality, these are relevant to our population of patients with diabetes and linked to long-term outcomes.[47,94] Future work should assess broader, more patient-oriented long-term outcomes, such as health related quality of life and mortality, and include more patient socio-demographic and context measures.

Implications

Our findings have several implications for the design of future multimorbidity interventions if borne out in future research. It is well-established that there is a potential to improve control through better self-care and better testing. Our results support targeted lifestyle interventions for patients with diabetes and co-occurring high-risk conditions (such as depression or obesity) who have suboptimal diabetes control for more than one goal. Patient-centered medical home elements, such as registries and group visits,[76] could target patients with specific diabetes comorbidities to provide supportive, integrated diabetes and comorbidity care.[53,86] This may also help patients and providers prioritize diabetes care goals where they can benefit multiple conditions,[82] and will maximize benefits while decreasing harms.[25,94] The importance of BP and LDL control alongside HbA1c control can also be emphasized. Additional pre-visit planning to ensure fasting lab completion,[76] or non-fasting lipid tests could be used to increase cholesterol testing.[154] Finally, given that over half of chronic conditions had no

relationship with chronic care, these conditions could be deemphasized in certain situations in order to create a more manageable lists of conditions for which care could be integrated.[49]

As diabetes rarely occurs outside the setting of multimorbidity, and multimorbidity complicates diabetes care, our data suggest that diabetes interventions urgently are needed that take into consideration the relationship of specific conditions to diabetes care goal achievement.

Table 1. Characteristics of Patients with Diabetes

	n=23,430
Comorbidities	
None (diabetes only, no other chronic conditions), %	7.7
Number total comorbid conditions, m (SD)	3.8 (2.5)
Optimal diabetes care for each goal, %	
HbA1c control	62
LDL cholesterol control	57
Blood pressure control	51
HbA1c testing	73
LDL cholesterol testing	87
Kidney testing	80
Demographics and Health Care Utilization	
Age, m (SD)	57.6 (11.5)
Sex, female, %	48
Race/ethnicity, white, %	70
Insurance, %	
commercial	50
Medicare	33
Medicaid	6
uninsured/unreported	12
Medicaid ever, %	6
Number of 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)

%=percentage; m=mean; SD=standard deviation

Table 2: Relationship of Individual Chronic Conditions to Diabetes Control, *adjusted, OR (95% CI)*, with prevalence of condition among patients with diabetes age 18-75 years

		Diabetes Control Goal					
	Prevalence, % (n=24,430)	HbA1c Control		LDL cholesterol control		Blood Pressure control	
Chronic Conditions		OR	95% CI	OR	95% CI	OR	95% CI
Conditions Related to Suboptimal Control							
Obesity	22	0.91	(0.84-0.97)			0.91	(0.85-0.97)
Depression	15	0.87	(0.80-0.95)				
Skin Ulcer	4.8	0.79	(0.69-0.91)				
Degenerative Eye Disease	4.3	0.72	(0.62-0.83)				
CNS/PNS Disorders*	7.8	0.8	(0.71-0.89)				
Thrombosis and Embolism	0.1			0.4	(0.2-0.96)		
Substance-use Disorders	0.8			0.7	(0.5-0.9)	0.58	(0.43-0.79)
Renal Failure	11					0.9	(0.82-0.99)
Lupus	0.5					0.67	(0.45-0.98)
Conditions Related to Both Suboptimal and Optimal Control							
Hypertension	74	1.1	(1.04-1.2)	1.2	(1.1-1.3)	0.6	(0.55-0.63)
Anxiety Disorders	8.0	1.1	(1.03-1.3)	0.8	(0.76-0.93)		
Congestive Heart Failure	5.0			0.8	(0.74-0.97)	1.2	(1.05-1.4)
Conditions Related to Optimal Control							
Hyperlipidemia	77	1.1	(1.1-1.2)	1.3	(1.2-1.3)	1.3	(1.2-1.3)
Coronary Atherosclerosis	14	1.3	(1.2-1.4)	1.5	(1.4-1.6)	1.3	(1.2-1.4)
Aneurysm	0.7	1.9	(1.2-3.0)	1.5	(1.02-2.1)		
Benign Prostatic Hypertrophy	4.1	1.3	(1.1-1.6)	1.2	(1.05-1.4)		
Cardiac Dysrhythmia	7.3	1.2	(1.04-1.3)			1.2	(1.1-1.3)
Parkinson's Disease	0.4	2.8	(1.4-5.4)			2.4	(1.5-3.9)
Vascular Disease†	2.8	1.3	(1.1-1.5)				
Myocardial Infarction‡	0.5	1.97	(1.2-3.2)				
Polycystic Ovarian Syndrome	0.3	1.8	(1.1-2.8)				
Allergic Rhinitis	11	1.2	(1.1-1.3)				
Gout	4.4	1.2	(1.1-1.4)				
Hepatitis	0.5	1.8	(1.2-2.7)				
Epilepsy	0.7	2.2	(1.5-3.2)				
Esophageal Disorder	1.1	1.4	(1.01-1.8)				
Cancer	7.6	1.3	(1.1-1.4)				
Osteoarthritis	16	1.2	(1.1-1.3)				
Rheumatoid Arthritis	1.5	1.7	(1.3-2.2)				
Schizophrenia and Psychotic Disorders	1.1	1.6	(1.2-2.2)				
Bipolar disorder	3.7	1.2	(1.1-1.4)				
Menopause and Perimenopause	3.6	1.2	(1.1-1.5)				
Multiple Sclerosis	0.4	1.6	(1.01-2.6)				
Kidney and Vesicoureteral Disorders§	4.8			1.2	(1.1-1.4)	1.2	(1.01-1.3)
Dementia	1.3					1.3	(1.03-1.7)

Optimal care is achievement of the goal in the reporting year; Suboptimal care is lack of achievement of the goal. Goals are per American Diabetes Association 2011 guidelines (reporting year).[136]

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

Only significant results are shown
All condition categories are mutually exclusive
*CNS/PNS=central nervous system and peripheral nervous system and excludes malignancies, multiple sclerosis, epilepsy;
†non-thrombotic, non-atherosclerotic; ‡within past 2 years; §excludes kidney failure

Table 3: Relationship of Individual Chronic Conditions to Diabetes Testing, *adjusted, OR (95% CI),* with prevalence of condition among patients with diabetes age 18-75 years

	Prevalence, % (n=24,430)	Diabetes Testing Goal					
		HbA1c testing		LDL cholesterol testing		Kidney testing	
Chronic Conditions		OR	95% CI	OR	95% CI	OR	95% CI
Conditions Related to Suboptimal Testing							
Substance-use Disorders	0.8	0.7	(0.5-0.9)	0.57	(0.40-0.80)		
Depression	15			0.88	(0.79-0.99)	0.90	(0.82-0.99)
Congestive Heart Failure	5			0.66	(0.55-0.79)		
Thrombosis and Embolism	0.1			0.35	(0.13-0.96)		
COPD or Asthma	13			0.86	(0.76-0.98)		
Anemia	0.4			0.42	(0.24-0.71)		
Rheumatoid Arthritis	1.5			0.72	(0.54-0.98)		
Immunity Disorder	0.3			0.49	(0.27-0.89)		
Skin Ulcer	4.8			0.81	(0.68-0.97)		
Hepatitis	0.5					0.64	(0.41-0.99)
Conditions Related to Optimal Testing							
Hyperlipidemia	77	1.4	(1.3-1.5)	2.9	(2.7-3.2)	1.4	(1.3-1.5)
Liver Disease*	2.8	1.3	(1.03-1.5)	1.4	(1.05-1.8)		
Renal Failure	11	1.3	(1.2-1.5)			29.1	(18.6-45.4)
Hypertension	74	1.1	(1.03-1.2)				
Obesity	22	1.2	(1.1-1.3)				
Thyroid disorder	15	1.2	(1.1-1.3)				
CNS/PNS Disorders†	7.8	1.2	(1.1-1.4)				
Benign Prostatic Hypertrophy	4.1					1.2	(1.002-1.5)
Kidney and Vesicoureteral Disorders‡	4.8					2.0	(1.5-2.7)
Cancer	7.6					1.2	(1.001-1.3)
Menopause and Perimenoapuse	3.6			1.5	(1.1-1.9)		
Intestinal Disorders	2.1			1.4	(1.01-1.9)		
Coronary Atherosclerosis	14			1.3	(1.1-1.5)		
Allergic rhinitis	11			1.2	(1.03-1.4)		
Lupus	0.5			2.3	(1.04-4.9)		

Optimal care is achievement of the goal in the reporting year; Suboptimal care is lack of achievement of the goal. Goals are per American Diabetes Association 2011 guidelines (reporting year).[136]

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

Only significant results are shown

All condition categories are mutually exclusive

COPD=Chronic Obstructive Pulmonary Disease

†CNS/PNS=central nervous system and peripheral nervous system and excludes malignancies, multiple sclerosis, epilepsy

*excludes chronic hepatitis, ‡excludes kidney failure;

Table 4: Individual Chronic Conditions Not Related to Diabetes Control or Testing

Related to Neither Control nor Testing	Related to Testing but not Control	Related to Control but not Testing
Cardiac, Vascular, and Pulmonary Conditions	*Cardiac, Vascular, and Pulmonary Conditions*	*Cardiac, Vascular, and Pulmonary Conditions*
Stroke and TIA	COPD or Asthma	Myocardial Infarction
Cardiomyopathy	*Gastrointestinal Conditions*	Aneurysm
Congenital Heart Disease	Intestinal Disorders	Vascular Disease†
Peripheral Atherosclerosis	Liver Disease*	Cardiac Dysrhythmia
Pulmonary Heart Disease	*Allergy and Immunity Conditions*	*Musculoskeletal conditions*
Heart Valve Disorder	Immunity Disorder	Osteoarthritis
Musculoskeletal Conditions	Lupus	Gout
Back Problem	*Hematologic and Oncologic Conditions*	*Mental Health Conditions*
Mental Health Conditions	Anemia	Schizophrenia
Behavior Disorders	*Endocrine Conditions*	Anxiety Disorders
Personality Disorder	Thyroid Disorder	Bipolar Disorder
Sleep Disorders		*Gastrointestinal Conditions*
Gastrointestinal Conditions		Esophageal Disorder
Pancreatitis		Chronic Hepatitis
Genitourinary and Reproductive Conditions		*Genitourinary and Reproductive Conditions*
Female Genitourinary Disorders		Polycystic Ovarian Syndrome
Allergy and Immunity Conditions		
Tuberculosis		*Neurologic Conditions*
HIV		Dementia
Hematologic and Oncologic Conditions		Epilepsy
Sickle Cell Anemia		Multiple Sclerosis
Neurologic Conditions		Parkinson's Disease
Paralysis		*Other conditions*
Migraines		Degenerative Eye Disorder
Other conditions		
Non-Cardiac Congenital Disorder		
Sarcoidosis		
Amyloidosis		
Cystic Fibrosis		

COPD=Chronic Obstructive Pulmonary Disease

*excluding chronic hepatitis; †non-thrombotic, non-atherosclerotic

Supplementary Table: Prevalence of 62 Individual Chronic Conditions in Patients with Diabetes, 18-75 years old

Condition	Prevalence, % (n=24,430)
Cardiac, vascular, and pulmonary conditions	
Hyperlipidemia	77
Hypertension	74
Coronary Atherosclerosis	14
Asthma or COPD (chronic obstructive pulmonary disease)	13
Cardiac Dysrhythmia	7.3
Congestive Heart Failure	5
Cerebrovascular Disease	4.3
Peripheral Atherosclerosis	4.2
Vascular disease, non-thrombotic, non-atherosclerotic	2.8
Cardiomyopathy	2.4
Heart Valve Disorder	2
Pulmonary Heart Disease	1.6
Aneurysm	0.7
Myocardial Infarction within 2 years	0.5
Congenital Heart Disease	0.4
Thrombosis and Embolism	0.1
Musculoskeletal conditions	
Osteoarthritis	16
Back Problem	6.8
Gout and Other Crystal Arthropathies	4.4
Mental Health Conditions	
Depression and Depressive Disorders	15
Anxiety Disorders	8.0
Bipolar Disorder	3.7
Schizophrenia and Psychotic Disorders	1.1
Behavior Disorders	0.8
Substance-use Disorders	0.8
Personality Disorder	0.5
Sleep Disorders	0.4
Gastrointestinal Conditions	
Liver Disease (excluding chronic hepatitis)	2.8
Intestinal Disorder	2.1
Esophageal disorder	1.1
Hepatitis	0.5
Pancreatitis	0.4
Genitourinary and Reproductive Conditions	
Renal Failure	11
Kidney and Vesicoureteral Disorders (excluding renal failure)	4.8
Benign Prostatic Hypertrophy	4.1
Menopause and Perimenopause	3.6

Female Genitourinary Disorders	1.2
Polycystic Ovarian Syndrome	0.3
Allergy and Immunity Conditions	
Allergic Rhinitis	11
Rheumatoid Arthritis	1.5
Immunity disorder	0.3
Human Immunodeficiency Virus	0.2
Lupus	0.5
Tuberculosis	0.01
Hematologic and Oncologic Conditions	
Cancer	7.6
Anemia	0.4
Sickle Cell Anemia	0.02
Neurologic Conditions	
Central and Peripheral Nervous System Disorders (not otherwise listed)	7.8
Migraines	2.3
Dementia	1.3
Epilepsy	0.7
Paralysis	0.5
Parkinson's Disease	0.4
Multiple Sclerosis	0.4
Endocrine conditions	
Thyroid Disorder	15
Other conditions	
Obesity	22
Degenerative Eye Disorder	4.3
Skin Ulcer, Chronic	4.8
Non-Cardiac Congenital Disorder	2.3
Sarcoidosis	0.4
Amyloidosis	0.03
Cystic Fibrosis	0.03

CHAPTER 9. CONCLUSION

9.1. Summary of Results

This study demonstrated that chronic conditions have an impact on diabetes care quality in the setting of multimorbidity, and the impact for each condition varies by care goal. In the first paper, we found that chronic conditions often share care with diabetes, even if it is only a single care goal. Using the summary of overlapping care goals between a comorbidity and diabetes, we were able to determine concordance or discordance with respect to our diabetes care goals of interest, a method that has not previously been used. In the second paper, we assessed the usefulness of a method to quantify the burden of multimorbidity that does not consider all conditions equal by dividing conditions into concordant and discordant condition counts. The concordance of a patient's multimorbidity profile with diabetes care seems to matter more than the discordance or total number of conditions in the profile, contrary to the original framework on which this study was based. We also found that the impact of multimorbidity on diabetes care was different for different diabetes care goals. In the third paper, we focused on the impact of individual conditions, controlling for several other health-related factors to attempt to isolate the impact of the conditions. We found that only certain concordant conditions are associated with optimal care, while other concordant and discordant conditions are associated with suboptimal care, and whether care is optimal or suboptimal with each condition varies by care goal. More factors, beyond concordance and discordance, matter in the impact chronic conditions have on diabetes care goal achievement, as theorized in our enhanced framework. While this study was, by design, index-disease centered, it is a first step towards testing

approaches to measure the impact of multimorbidity that can be used in the future without an index condition. This study suggests that future interventions can be designed to integrate care goals in diabetes and multimorbidity, and to target patients at risk of suboptimal care, for specific care goals, due to their multimorbidity profiles.

9.1.1 Summary of Paper 1 Results

First, we demonstrated the overlap in care goals between diabetes and a comprehensive set of 62 ambulatory-relevant chronic conditions that we developed for this study. Primary care providers indicated if diabetes care goals were also care goals for the other chronic conditions. We chose to use expert primary care provider opinion, rather than guidelines, as this would best demonstrate how providers currently think about and manage chronic conditions in primary care. We found that chronic conditions share 0-4/5 care goals with diabetes, with 12 conditions sharing the majority of 5 care goals (concordant). Importantly, we demonstrated that conditions that share the majority of care goals with diabetes care can share different care goals from each other, so that 2 concordant conditions might not share the exact same care goals with diabetes. We also found that conditions that did not share the majority of diabetes care goals (discordant), did, in many cases, share 1-2 care goals with diabetes, so that even conditions that are summarized as not sharing care with diabetes do share care on a smaller level. This work supported the hypothesis that patterns of goal-based concordance and goal-based discordance will vary by chronic condition.

9.1.1 Summary of Paper 2 Results

Second, we examined how the number and mix of concordant and discordant conditions impact diabetes care goal achievement, considering all concordant conditions to have an equal impact on diabetes care, and all discordant conditions to have an equal impact. After determining if each of the 62 chronic conditions was concordant or discordant with diabetes, we fit logistic regression models with the count of concordant conditions and the count of discordant conditions as our explanatory variables. As expected, a higher count of concordant conditions was, in general, associated with better diabetes care goal achievement. However, blood pressure control was less likely with 2+ concordant conditions.

Contrary to what we expected, however, a higher count of discordant conditions was not associated with worse care achievement, in general, but rather associated with no or minimally better diabetes care goal achievement. We also added interaction terms to evaluate if the impact of count of concordant conditions changed as the count of discordant conditions changed, or vice versa, and found that the mix of concordant and discordant conditions did not matter over the separate count of concordant conditions and count of discordant conditions.

9.1.3 Summary of Paper 3 Results

Finally, we demonstrated that individual chronic conditions are related to diabetes care goal achievement in different patterns than would be expected from their concordance or discordance (based on shared care goals). In this study, we fit logistic regression

models for each of 6 diabetes care goals and the 62 individual chronic conditions, without regard to their concordance or discordance. As expected, we found that conditions were related to optimal or suboptimal care for some care goals, and not related to care goal achievement for other care goals.

More specifically, similar to what we saw using counts of discordant conditions in Paper 2, we found that conditions that did not share the LDL testing goal with diabetes were associated with suboptimal LDL testing. Additionally, we found that many conditions that did share care goals with diabetes were related to achievement of those goals. However, contrary to what we expected, we found that specific other conditions that shared care goals with diabetes were related to suboptimal care, or not related to diabetes care. A striking example is both hypertension and obesity, which were related to suboptimal blood pressure care in Paper 3 but were classified as concordant with blood pressure care in Paper 1 and counted as concordant conditions in Paper 2. These 2 conditions could be behind the negative association between concordant conditions and blood pressure control seen in Paper 2. While the concordance-discordance framework suggested that the overlap in care between these conditions and blood pressure control in diabetes should support goal achievement, it is also likely that factors contributing to the development of these diabetes-related conditions could also contribute to worse blood pressure control, such as pathophysiologic changes and lifestyle factors.

Also contrary to our expectations, some conditions that were discordant with diabetes, and would typically be considered symptomatic or clinically dominant, such as osteoarthritis or cancer, were related to optimal diabetes care goal achievement. Clearly, a combination of factors, beyond concordance or discordance alone, influences a condition's association with diabetes care goal achievement. Additionally, the impact of a condition on diabetes care is not uniform across all care, and should be considered for each specific goal.

9.2 Summary of Conclusions From the Papers

This study builds on the theory that there are Competing Demands for time and financial resources patient care, in the health system and with self-care, and conditions that share care with diabetes are more likely to have diabetes care completed through support of care and lack of competition, while conditions that do not share diabetes care will lead to reduced diabetes care goal achievement through competition and distraction. A major goal in multimorbidity research is to determine a method to define and measure multimorbidity, and its impact, for clinical and research uses. The measurement technique should be as simple and as complete as possible, a difficult challenge for such a heterogeneous and complex population.

9.2.1 Major Contributions to the Field

This study makes several major contributions to the field. First, it demonstrates that a count of concordant and a count of discordant conditions provides more detail than a total count of conditions to measure the impact of multimorbidity on patients with

diabetes, and to identify patients at risk for suboptimal care in diabetes. Second, it demonstrates that concordance has more of an impact on achieving the selected care goals than discordance. Third, it showed that individual conditions have different impacts on diabetes care goal achievement than other conditions, and different from what might be expected due to shared care goals. This finding suggests that more factors than concordance and discordance matter in determining the impact of multimorbidity on diabetes care, and that conditions cannot be assumed to have an equal impact in all cases (as with counts.) Finally, it demonstrated that the impact of concordance and discordance, and of individual conditions, is different for different care goals, suggesting that care goals should be considered independently in multimorbidity, rather than generalizing that overall care is better or worse due to multimorbidity.

9.2.2. Role of Discordance

While we found that counts of discordant conditions had a limited impact on diabetes car goal achievement (or not), that does not mean that discordant conditions are unimportant or should be disregarded in multimorbidity care. Our study found that 50 of 62 conditions were discordant, across 10 organ systems. The diversity of these conditions presents a challenge in generalizing conclusions across all discordant conditions, as does the variance in potential severity of conditions *(e.g.*, between heartburn and cancer). Additionally, although we did not find much impact from the count of discordant conditions, we did find an impact from certain individual conditions, in Paper 3, that were determined to be discordant in Paper 1. We also found a

discordant impact, that is, an association between the condition and suboptimal care, for certain conditions that were determined to be concordant in Paper 1.

The outcomes tested were all publicly reported quality metrics that come from national diabetes treatment guidelines. It is possible that providers are more attentive to achieving these care goals, for both the patients' health and their professional standing. These well-known and publically reported outcomes might be more robust to the potential distraction of discordant co-morbidities due to this heightened attention and to changes made to work flow to ensure publically reported care goals are achieved, such as reminding providers of their public reporting performance and computerized pop-up reminders. Discordance might play a greater role in reducing care goal achievement for less well-known and/or non-publically reported care goals. We also note that we tested this theory with specific diabetes care goals in a single population. Discordance of comorbidities does play a role in diabetes care, just not for all conditions, and it might be less important in distracting from care, at least for these outcomes and in this population, than theorized in the concordance-discordance framework.

9.2.3 Role of Factors Beyond Concordance and Discordance

We also found, between Papers 2 and 3, that the overlap in care goals between diabetes and other conditions, that is, the diabetes concordance and discordance, does not fully describe the impact of multimorbidity on diabetes care. This is not surprising, and underlines that other factors must be considered. These factors include factors that are tied to the condition, such as severity and clinical dominance, and factors that come

from the patient, provider and system, either attached to the condition, such as preference for care for the condition or presence of disease registries for the condition, or larger contextual factors. Pathophysiology plays a role as well, since the conditions with overlapping care with diabetes also share pathophysiology with diabetes, so that some care, such as lifestyle changes, can improve care goal achievement for more than care goal (such as LDL control and BP control). However, share pathophysiology can make control more difficult, as changes with obesity could make HbA1c control more challenging in diabetes, for example.

9.2.4 Measuring Multimorbidity

One of the major goals of this study was to help the field move forward on a technique to quantify the impact of multimorbidity in order to target intervention to the most appropriate patients, conditions and care goals. A count of total conditions is simple but incomplete, as it equates all conditions to each other. A count of concordant and discordant conditions adds important detail, but leaves out additional factors that influence care, such as symptoms and patient preference, that might make one condition have a greater impact on care than another, and also counts conditions that have minimal or no impact on care. Using the presence of individual conditions allows conditions to stand independently, with individual impacts on care. However, if all conditions are used, this large number of conditions could be unmanageable, especially for identifying patients for different care interventions in a clinical setting. Our study offers a more manageable list of conditions with an impact on care, and suggests that we might be able to reduce the conditions of interest in multimorbidity to a select set

that have a greater impact on care than other conditions. The presence of any of these conditions could be used to quantify multimorbidity. A count of these conditions (selected count) or a count of conditions associate with optimal care and with suboptimal care, perhaps weighted, could be combined to create an index. There will need to be a balance between richness of information (as with using indicators for the presence of each or many conditions) and simplicity of use (such as a count of a score). Additionally, future work will need to test if the impact of the conditions is different in different populations, as has been seen in previous chronic condition work by Elixhauser.[155]

9.2.5 Multimorbidity versus Comorbidity

The choice of approach measure the impact of multimorbidity relates to the definition of multimorbidity versus index condition and comorbidity. This study was done in patients with diabetes, for diabetes care goals, a design that is index disease-centric. This approach was chosen as an initial test of the conceptual model in a complex, common chronic condition. Ideally, future work will expand to consider other non-diabetes outcomes and patients without diabetes. However, from a practical standpoint, research and interventions might be best applied to patients who have at least one condition or care goal in common, to avoid some difficulties inherent to working with a heterogeneous population. Among the Medicare population, there are over 2 million combinations of chronic conditions,[156] and most current interventions tested in multimorbidity used outcomes that were too broad, to fit the needs of a heterogeneous population, to study and reproduce in other populations.[94] This creates a paradox of

needing interventions to both broad and inclusive for multimorbidity and outcomes that are relevant across all conditions, while targeted in their approach to be relevant to the patients they serve and have meaningful and measurable outcomes.

Given the challenges of providing care to such a heterogeneous population, conditions a recently suggested approach is to study condition dyads and triads.[11] By focusing on patients with 2-3 conditions in common, interventions can be well-targeted while also being broader that single-disease interventions. They can also aim to improve for general health and specific health care outcomes. If interventions are targeted at high prevalence or high cost dyads and triads, the impact of improving health will be felt for more patients and should results in greater cost savings.[11] The work presented in Paper 3 measures the impact of diabetes-containing dyads, as it shows the association between care goal achievement for patients with diabetes plus another condition, averaged over other conditions. A focus on dyads or triads of conditions is a step beyond single-disease plus comorbidities, and a reasonable first step towards true multimorbid care. Finally, as techniques to measure and quantify multimorbidity evolve, we must not forget the desires of patients. Their view on the measurement of multimorbidity, and opinion on how it should be managed, from a holistic approach to a divide-and-conquer approach, must be assessed and considered as we move towards multimorbidity interventions.

9.3. Limitations

This work does have limitations. Several of these are discussed in context of the individual papers (Chapters 6-8). This section will describe a few of these in greater detail, as well as overall limitations of the entire study.

9.3.1 Study Design

9.3.1.1 Study Design - Paper 1

The first paper used a modified Delphi approach to determine consensus opinion on care goal overlap between diabetes and chronic conditions. By design, we aimed for a majority opinion, and do not that this ignores any non-majority opinion that might have clinical relevance. We chose to use expert opinion, rather than guidelines for 2 major reasons: 1, patients are treated based on provider professional judgment (potentially influenced by guidelines) rather than strictly by guideline protocol, and 2, lack of guidelines for many conditions. Since the Delphi method measures provider opinion of which of the listed diabetes care goals should be met for each of the 62 conditions, this study could measure provider preference for care in each of these conditions. This could lead the results in Paper 2 to be somewhat self-fulfilling, as primary care providers might be more likely to achieve care goals that other primary care providers have deemed necessary. We also note that patient opinion does not have a role in our Delphi approach, as we were interested in soliciting provider medical opinion for shared medical management between diabetes and other conditions. The Delphi results only demonstrate ideal care in a patient with a single chronic condition, per primary care providers, not actual dispensed care as a result of unique patient needs and shared

decision-making. Clinical care does becomes more complex than an ideal situation, and the results of Paper 2 reflect not only provider opinion of what care is ideally given, but also provider preference, and to some degree, patient preference, for what care is given to individual patients with additional conditions and other health care and non-health needs. For example, deferring LDL cholesterol testing in someone with an inability to return to the clinic fasting, or allowing blood pressure to remain elevated until chronic pain is controlled. In Paper 3, we suggest that multiple factors, including provider preference for care, contribute to care goals achieved. We compare the care goal overlap found in Paper 1 to the results found in Paper 3, and find some alignment and some misalignment between care goal overlap and care goal achievement. It is possible that some of the care goal achievement found in Paper 3 is due to provider preference for care, as partially determined in Paper 1, but determining the role of provider preference is outside the scope of this study. Future work can disentangle the roles of multiple factors that influence the association between multimorbidity and diabetes care goal achievement.

9.3.1.2. Study Design - Paper 2

The study design itself is not necessarily a limitation. This study was retrospective and observational, rather than a prospective randomized controlled trial (RCT) has long been the gold standard in clinical research. An observational design might seem to be a limitation. However, the Department of Health and Human Services has recognized the limitations in currently available research in multimorbidity and has made it a priority to expand research efforts and our understanding of the epidemiology of

multimorbidity.[21,67] Additionally, few RCTs relevant to multimorbidity care have been done, as many RCTs exclude patients with multimorbidity or do not collect information on the study participants' chronic conditions.[38,51] To this end, researchers have suggested that observation studies are fast and thorough to study the epidemiology and impact of multimorbidity.[67,92] Studies focusing on a single disease, such as this one that focuses on diabetes, are helpful to understand the multimorbidity as it impacts the index condition, and could be extrapolated to other conditions with similar care or treatment.[94]

As with all studies, this study has a potential for Type I error based on our chosen significance threshold. We chose a p-value of 0.05 based on the standard in medical research, giving a 5% chance of a Type 1 error. The Bonferroni correction or the Benjamini-Hochberg method could be used to reduce Type 1 error in our multiple-comparisons situation, but it is not necessary as it could increase our false negatives (Type 2 error) and would be overly conservative.[157,158] With a large sample size, it becomes more likely to detect significant differences that might have no clinical significance. In our study, which serves as an initial test of a health-services conceptual model, we would prefer to detect significance that is not there than to miss significance that is there.[159] We do note that we risk Type 1 error for the borderline significant results by choosing not to use a multiple-comparison correction, and we should be cautious to make conclusion for the borderline significant results. Further studies in different populations can verify our results, especially those with borderline significance.

Our sample size was relatively large, increasing our power to detect significant effects, and avoid Type 2 error. However, we recognize that the number of predictors in our analyses (over 60 in Paper 3) could reduce the power to detect effects, especially as some conditions are low prevalence, leading to an effective lower sample size for those conditions. Conditions that are uncommon comorbidities in diabetes are unlikely to have a significant impact on diabetes care at a population level however, and so this might be an acceptable Type 2 error. Future studies should investigate these low prevalence conditions if they are of interest.

9.3.2 Study Population

9.3.2.1 Study Population – Paper 1

This study was also limited in the population and source of the data. The first paper out of this study (Chapter 6) used a panel of expert primary care providers, family medicine and internal medicine, from the same academic institution. It is possible that internists and family physicians handle care differently, for instance if one specialty relied more heavily on guidelines than another. Practice styles do vary between these specialties, with internal medicine associated with a more biomedical approach and family medicine with a psychosocial, patient-centered approach.[160,161] However, it is unclear if differences in approach lead to differences in testing and treatment patterns, as a single study on diagnostic accuracy and treatment outcomes included internal medicine and family medicine grouped together as “primary care physicians”.[162] An older study showed differences in patient mix between internists and family physicians, where internists tend to have older patients with more numerous and more severe chronic

illnesses compared to family physicians,[163] but this might not currently be the case. It is possible that differences in patient mix and practice style would lead to difference in responses on the survey between family and internal medicine, but that is not clear. Additionally, we were looking for a consensus opinion among providers who manage patients in ambulatory care, rather than the "right" answer, and so difference in care management between specialties or between providers is less pressing. An additional issue could be that academic providers, especially from a single institution, might have different opinions on chronic condition management than providers outside of academics or at different institutions with different practice patterns. It is possible that meeting diabetes care metrics is emphasized in some institutions or practice environments more than in others. However, medical education, examinations and continuing medical education literature are nationally standardized, and NCQA/HEDIS measures are recognized nationally, reducing potential "institution bias." Additionally, the providers who served on the Delphi panel are from a similar geographic location and practice setting as many of the patients in Paper 2 that used the results from Paper 1.

9.3.2.2 Study Population – Papers 2 & 3

For Papers 2 and 3, all participants were seen at 7 health systems in the same Midwestern state that participate in a voluntary state-wide public reporting initiative. While the state is less diverse than the general population of the US, the data nevertheless represents a range of patient genders, ages, races/ethnicities and payors. Future work could be done in a more diverse population that includes more elderly adults, as this sample did not include adults over 75 as they are not part of public quality

reporting. Also, as this data is from health systems that voluntarily contribute to public reporting,[61] these systems could have different patients and patient management approaches than other health systems. The achievement of diabetes quality metrics 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.[12] There is a theoretical chance that the health systems biased their own data, only reporting the "good" patients. However, an established algorithm from the external public reporting collaborative was used across all systems to identify patients with diabetes, their diabetes metric achievement and their chronic conditions. Further, the systems were unaware of the study or its hypotheses prior to data collection. Health systems were identified by number and not name in the analytic data set to reduce researcher bias. We did control for the health system and potential contextual factors for the health systems in our analysis by creating variables for the percentage of people in the patient's county with diabetes and with suboptimal glycemic testing. Future work she test the results of this study in other populations to determine if the effect persists beyond our population and to examine changes in the effect in other populations as was seen in Elixhauser's study of comorbidities in different populations.[155]

9.3.3 Control Variables – Papers 2 & 3

The data were also limited in their inclusion of socio-demographic, patient context and health care utilization variables.

9.3.3.1 Socio-demographic and Patient Context Variables

Socio-demographic and patient psycho-social and cultural context can have a major impact on health care and outcomes, especially in multimorbidity.[36] While we were able to adjust for patient age, gender, race and health insurance status, we did not have patient-level data for income or education level. To alleviate part of this limitation, we created surrogate socioeconomic status variables representing if a patient has ever been on Medicaid, and the poverty and education level of the population in the patient's zip code, based on census data. Additionally, we were limited in our lack of environment or other contextual measures, such as access to health care, language and self-advocacy ability.[36,107] Consider patient context is paramount to providing patient-centered, holistic health care. This study was a first step towards understanding the impact of multimorbidity on diabetes care, and additional socio-demographic and context control variables should be added in future work to fully explore the impact of multimorbidity on diabetes health.

9.3.3.2. Health Care Utilization Variables

To adjust for health care utilization, as the number of interactions with the health system could impact diabetes care goal achievement,[80] we used the number of face-to-face office visits in the baseline year. However, much of clinical care for multimorbidity, potentially two thirds of provider time, is done outside of visits (e.g., phone calls, letters) and we were unable to control for these interactions. [61,141,164] It is possible that between visit contacts follows the same pattern as E&M visits *(i.e.,* few phone calls for patients seen few times, many phone calls for those seen many times) and therefore the number of office visits is a good measure of overall health care interactions, but we do not know

this. Future research using all health care utilization would be beneficial, especially before designing interventions that aim to modify health care utilization.

9.3.4 Chronic Conditions Papers 1-3

Finally, our method of attributing chronic conditions to patients has limitations. First, chronic conditions for our study were defined using ICD-9 codes, limited to chronic conditions, which were then grouped together clinically, based on CCS categories of similar conditions as was done in previous work.[30,31] This approach covered 1,412 ICD-9 codes determined in previous work to be chronic and outpatient-relevant and is meant not to exclude any chronic conditions.[30 31] This definition of chronic condition is based on clinical knowledge and the medical approach to determining conditions, and therefore has clinical relevance as well as research relevance. It does have the potential to under count conditions that are similar enough to be grouped together, for example, long QT syndrome and atrial fibrillation. It also includes as medical conditions, by definition with the ICD-9 and CSS approach, conditions such as obesity and hyperlipidemia that might also be considered risk factors or patient characteristics.

We determined a patient's current, active chronic conditions for Papers 2 and 3 using the method described in detail in Appendix 5. We chose to identify conditions that were billed in the baseline year to ensure that the conditions were current and actively managed to prevent "over diagnosis" of problems that appear in the patient's medical history but are not currently supporting or distracting from diabetes care. We used a single code (one billed episode of care) to reduce underdiagnosis of comorbidities, and

we chose to only include conditions billed in the baseline year to ensure the condition existed prior to the patient meeting any metrics in the reporting year. Defining chronic conditions as those billed using ICD-9 codes has been used previously[30,31] but presents the issue of missing conditions that are underdiagnosed in billing, such as obesity[152] and mental health conditions.[165] In the case of underdiagnosis, the patients with billed diagnosis codes for the conditions likely have more severe or more symptomatic disease, such as obesity contributing to uncontrolled diabetes, as the conditions in these patients were significant enough to be discussed and listed in the billing for the encounter. If this is the case, then the impact from these billed ICD-9 codes could be greater than the impact from the same ICD-9 code that was unbilled in other patients, meaning that the true impact of multimorbidity is less than we found in these studies. Additionally, different providers might have different billing (diagnosing) patterns, billing more conditions in their patients while other providers bill fewer, for patients with similar conditions. We capped the count of concordant and discordant conditions in Paper 2 to reduce the impact of the few patients with extremely high numbers of diagnosed conditions (up to 22 conditions).

9.3.5. Outcome Variables (Care Goals)

This study was designed to examine the achievement of diabetes care goals as prescribed in guidelines to reduce severe complications and measured in quality reporting[47,61] in patients with diabetes and multimorbidity. This is an intentionally diabetes-centric approach, as patients with diabetes commonly have multimorbidity (92% of patients in our sample) and need improved care. Diabetes is also an ideal

condition to study as a first step towards complete multimorbid care (without an index condition), as diabetes is common, has complex treatments demands and occurs in patients of all ages, genders and races/ethnicities. The use of disease-specific outcomes is challenging in multimorbidity, as they are often mainly relevant to one condition, and the achievement of these care goals might be of little additional benefit or possibly cause harm.[15] However, specific care goals, such as the diabetes metrics, are easy to measure, standardized, and validated to longer term outcomes, including the development of additional chronic conditions and mortality, and therefore are appropriate to study and target in interventions in multimorbidity.[15] They are also appropriate for use in research and interventions for the subgroup of patients we are studying, patients with diabetes.[15]

These care goals are also appropriate as they span the spectrum of care, from testing to control, glycemic and non-glycemic care, and to prevent both microvascular and macrovascular outcomes. Achievement of these goals represents the combined efforts of providers, health systems and patients in diabetes management, and none of these care goals can be attributed entirely to the actions of a single individual or role (i.e., to the provider alone). However, testing is more provider and health care system-centric, as a health care worked needs to order the test and inform the patient when and where to have the test done. The patient needs to have the test done, and in some cases might remind the provider to order it, but the ordering is still the responsibility of the provider and health system. Testing outcomes would be expected to be more influenced by concordance and discordance at a health care visit. We did find that both concordant

and discordance were associated with optimal testing, and that more conditions that are considered concordant with diabetes were related to optimal testing than to suboptimal testing. Interestingly, testing was less likely for LDL for several individual conditions, suggesting the patient does have a role in testing metrics, as LDL testing, compared to HbA1c and kidney testing, requires a return fasting visit. Unfortunately, our data only allowed us to measure the completed lab tests, not labs that were ordered but not completed, to further assess the provider versus patient roles. Control, on the other hand, is typically considered more patient-centric than testing and represents the responsibilities of both health care and patient self-care. The health system must educate and in many situations, prescribe medication, while the patient must take the medication and perform healthy lifestyle behaviors on a daily basis. Control should be more difficult to achieve than testing as it requires medication adherence and lifestyle changes consistently over time and is susceptible to self-care concordance and discordance between office visits. The patients in our study were more likely to have achieved testing goals than control goals, unadjusted for comorbidities or other factors. In our regression analyses, we found that more conditions were associated with optimal control than with optimal testing. However, optimal testing needs to occur to in order to determine if there is optimal LDL control, and at least one HbA1c test needs to occur to determine if there is optimal HbA1c control (optimal testing is two tests), so the control results are already filtered somewhat for the level of testing. Our analysis was limited by lack of measurement of patient adherence to medications or lifestyle changes so we cannot measure the impact of patient self-care directly.

While the chosen metrics comprise a large and critical part of diabetes care, we recognize that these outcomes do not represent the entirety or diabetes care and outcomes as they are selected pathophysiologic markers of disease management and control, or “intermediate outcomes,” whereas patient-oriented outcomes such as quality of life and functional status might be more appropriate in multimorbidity.[15,51] As noted above, these intermediate outcomes are linked to longer term outcomes in diabetes and are used in public reporting and clinical care, and so are appropriate outcomes to target for improvement, especially as they can be standardized between populations and settings.[15,47,61] Finally, as these outcomes are widely used public reporting metrics, and often tied to provider and system reimbursement, it could be that providers and systems, and even patients, are more focused on completing these care goals than they might be on completing non-publically reported care goals. This could make these care goals robust to distraction from discordant conditions. Future studies should examine other measures of health in patients with diabetes and multimorbidity, including goals that are important but not publically reported, and attempt to differentiate the roles of provider, system and patients in goal achievement.

9.3.6 Causality

This study determined the relationship between the count of concordant and discordant conditions, and 62 individual chronic conditions, and diabetes care goal achievement. While we take an important step forward by determining the association between patient multimorbidity profiles and diabetes care goal achievement in this population, we cannot imply causation between the presence of the chronic conditions and diabetes care as a

result of this work. The count of concordant conditions, or the presence of a specific individual condition, does not necessarily cause a patient's diabetes care to be better or worse. In some cases, a patient's suboptimal diabetes care goal achievement could cause a comorbid condition to develop (and thereby cause an increase in concordant or discordant conditions). In other causes, a condition can cause worse control in diabetes due to pathophysiologic changes rather than due to degree of shared care goals. For example, the pathophysiologic changes associated with obesity, could make blood pressure control more difficult. We hypothesized that the combination of multiple factors leads to a condition being related to optimal or suboptimal care in diabetes, but we are unable to say that these factors lead the condition to cause optimal or suboptimal care. Future work, discussed in Section 9.4, should be done to explain why these relationships occur and examine causality.

9.4. Implications

Currently, there are limited guidelines and no interventions to improve care for patients with diabetes and multimorbidity.[25,94] Interventions for diabetes care in the setting of multimorbidity, and for multimorbidity, are lacking and urgently needed. A recent Cochrane review on multimorbidity interventions demonstrated the paucity of studies for patients with multimorbidity, including only a single study for multimorbidity that includes diabetes.[94] Commonly used interventions for chronic condition management, such as Wagner's Chronic Care Model, are single-disease focused without specific guidance on care in the context of multimorbidity.[34,89] This study provides new knowledge to inform guidelines and interventions.

9.4.1 Major Contributions to Inform Interventions and Guidelines

The US Department of Health and Human Services (DHHS), The Institute of Medicine (IOM), the Patient-Centered Outcome Research Institute, and others have recognized the need to integrate and prioritize care across multiple conditions and patient preferences to improve clinical practice guidelines for patients with multimorbidity.[21,36,51,67] Current diabetes guidelines do take comorbid conditions into account, with suggestions to modify glycemic control goals for certain comorbidities and a section towards the end of the guidelines providing care recommendations for several diabetes-related conditions. This study makes two important contributions to guideline improvement. One, it demonstrates that several traditionally non-diabetes related conditions (discordant conditions) are associated with suboptimal diabetes care goal achievement for some care goals, and these conditions should be addressed in the guidelines. Two, it provides specific condition-care goal combinations whose associations with optimal and suboptimal care can be explicitly mentioned throughout the guidelines, rather than addressing them in a separate section, as recommend by the DHHS and IOM.[67]

9.4.2 Conditions and Care Goals to Target with Interventions

This study provides important initial information for the development of diabetes care improvement interventions in the setting of multimorbidity. First, it responds to the DHHS goal to characterize the multimorbidity population by providing the prevalence of diabetes-chronic condition dyads and their diabetes care goal achievement.[21] This study also identifies condition combinations that have suboptimal care and defines diabetes-

multimorbidity subgroups (*i.e.,* diabetes-other condition dyads) that are likely to respond to interventions in similar ways, due to their shared conditions.[11,15,92] While there might still be a role for counts of conditions, especially more nuanced counts such as counts of concordant and counts of discordant conditions, it would be best to include only specific conditions shown to be related to optimal or suboptimal diabetes care in these counts. Second, patients are more than a collection of individual conditions, and interventions need to recognize how conditions interact to impact overall health and health care needs.[49,166] Interventions, based on this study's findings and conceptual model, can target patients at-risk for suboptimal diabetes care based on their multimorbidity profiles (*i.e.*, count of concordant conditions or the presence or absence of individual conditions), for specific care goals, as conditions interact with diabetes care at the level of care goals. Further, this work also demonstrates diabetes care goal achievement in the presence of several mental health conditions so that these conditions can be included in interventions.[166] Third, this work provides a much-needed theoretically model on which to base interventions.[15] Care integration across multiple conditions could occur at a goal-level, especially focusing on synergistic care.[82] Patients with certain individual conditions could also be targeted for improvement of specific diabetes care goals, based on the relationship of the condition to suboptimal care goal achievement, and the potential benefit of achieving that care goal to both diabetes and the patient's other conditions. Multimorbidity interventions can aim to reduce symptoms, balance the care of clinically dominant conditions with other important but non-dominant conditions, and assess and revise, if appropriate, patient and provider preferences for care, to ensure optimal management of diabetes and comorbid conditions. Fourth, the

use of diabetes care goals in this study and conceptual model provides specific and measureable outcomes that can be targeted in interventions and that are sufficiently standardized for mass implementation of the interventions.[15] These measures can also be modified for patients' preferences (change control goal levels, disregard certain goals) and can be prioritized as part of prioritizing certain long-term health outcomes (e.g., cardiovascular risk reduction over glycemic control).[15] Fifth, understanding the relationship between individual conditions and suboptimal diabetes care will allow us to explore where care deficits are potentially appropriate, due to patient health status, or patient and family preferences. Finally, multimorbidity is heterogeneous, and over 2 million condition combinations have been identified in Medicare patients.[41] It is unrealistic to develop interventions for every possible combination.[35] There were no prior studies on the relationship between a comprehensive list of diabetes comorbid conditions and the achievement of several diabetes care goals. This study provides a more manageable list of conditions to target for quality improvement, and a more manageable goal-centric approach to multimorbidity care.

9.4.3 Enhance Self-Care

The DHHS suggests self-management as an important component of multimorbidity care, especially to reduce the development of additional chronic conditions.[21,167] As most diabetes care occurs between visits, self-care has a major impact on diabetes control goals. This study demonstrates that conditions with similar care goals are associated with better diabetes care, perhaps in part due to lifestyle changes that

improve glycemic and cholesterol control. More importantly, it demonstrates which specific conditions are related to suboptimal control for specific care goals, including cardiovascular care. Patients with these conditions can be educated on the increased potential for suboptimal care, and the importance of diabetes care goal achievement in conjunction with other care, if appropriate. This education is especially important when patient preference for care does not align with medical needs for diabetes care, as patients with less preference for diabetes care might not complete the care.[43,86] Additionally, prior work showed that patients with multimorbidity had better glycemic control when they were aware of their comorbidities.[168] Awareness of their comorbidities' relationship to diabetes care outcomes would likely improve diabetes self-care for those outcomes. Self-care is time consuming for diabetes, and worse when multimorbidity care needs are added.[32,134] However, an integration of care goals, and an understanding of the care goal overlap between diabetes and other conditions, would help minimalize this otherwise daunting list of care goals.[50] Interventions can focus on integrated self-care, combining a focus on synergistic care and reminders to complete specific care goals that are less likely to be achieved with multimorbidity profiles that have low concordance and/or specific individual conditions.

9.4.3 Improved Care Coordination

The DHHS also suggests well-coordinated care for patients with multimorbidity, and patient-centered medical care components can be enhanced to improve multimorbidity care.[21,76] Adding more and/or longer provider visits is one option to improve care, and although it doesn't provide care between visits, it could shorten time between visits (shorten time for patients without provider feedback) and increase time for patient self-

care education. Improved care coordination between visits could prove useful as well. In particular, chronic care managers and condition registries could be enhanced from diabetes-only lists to patients with diabetes and another specific condition that is associated with suboptimal care, such as diabetes-hypertension. Registries could even represent patients with 3 or 4 conditions, especially conditions that are common in diabetes, such as a diabetes-hypertension-hyperlipidemia-depression registry. These multimorbidity registries would reduce care compartmentalization and fragmentation from multiple phone calls and differ care coordinators that could be caused by single-condition registries. Group visits for patients with specific diabetes comorbidities could be useful, and integrate care for both conditions. For example, diabetes and depression would be ideal for this approach, as depression is highly prevalent in diabetes, it is associated with suboptimal diabetes care, and it is likely that worse control of either condition leads to worse control for the other.[169,170] Providers and other health care staff, such as medical assistants who room patients and chronic care managers, can be educated on conditions associated with suboptimal diabetes care, and diabetes care goals that are least likely to be achieved in multimorbidity care, to be more vigilant for these conditions and care goals. Providers likely have noticed that visits for concordant conditions feel “easier”, as synergistic care is efficient, and this study shows that concordance is associated with better diabetes care goal achievement. Providers and systems can be encouraged to continue to provide synergistic care, and to consider if diabetes care goals have been neglected in patients with few concordant conditions. Providers can also be reassured that the overall discordance of a patient’s multimorbidity profile was not associated with worse care, except for LDL cholesterol

testing. However, there are specific individual conditions that are associated with suboptimal care, hypothesized as being due to a combination of factors. Providers and care managers should consider the role of these other factors in their patients' care, and modify their care approach either to improve diabetes care or decide to defer diabetes care until other conditions are controlled.

9.5. Next Steps

This study takes a major step forward to improving care in multimorbidity that includes diabetes by developing goal-based diabetes concordance and discordance of chronic conditions, testing the impact of the count of concordance and discordance on diabetes testing and control goal achievement, and assessing the relationship between 62 individual chronic conditions and 6 diabetes care goals. However, it is still a first step. More work is needed to research, develop and test interventions before implementation.

9.5.1 Developing Algorithms to Identify Patients At-Risk for Suboptimal Care

Once these results are verified in future studies with different populations and a broader set of socio-demographic and contextual variables, they can inform pilot interventions to identify and treat patients at risk for suboptimal diabetes care in multimorbidity. Algorithms, using patients' multimorbidity profiles, both overall concordance and specific conditions, can identify patients who would most benefit from interventions. Identified patients can then receive targeted care, such as patient registries with care managers or group visits for "diabetes plus x," to determine if targeted care by comorbidity helps to improve overall diabetes and multimorbidity care. Interventions should first target

patients with the most prevalent conditions that are also associated with suboptimal diabetes care, such as hypertension, depression and heart failure, and in whom improve care is appropriate (*i.e.,* perhaps a focus on diabetes care is not appropriate in advanced dementia). The interventions can also target specific care goals, such as HbA1c control in depression and cholesterol control in heart failure. If the interventions are successful in improving care for a limited set of conditions in trial populations, they can be expanded to more conditions and to more populations.

9.5.2 Moving Towards Patients-Centered Multimorbidity Care

Additionally, to best develop and implement interventions that are truly patient-centered and for multimorbidity, rather than diabetes plus comorbidity, further research is needed. This work should explore the reasons why specific conditions are associated with suboptimal diabetes care quality, assess additional outcomes in multimorbidity, and take steps to integrate care goals for the comorbidities that aren't also diabetes care goals.

9.5.2.1 Research to Understand Why Conditions Are Associated with Optimal or Suboptimal Care

First, there should be an attempt to explain why certain conditions are related to optimal and suboptimal care, and why some concordant conditions are related to optimal diabetes care while other concordant conditions are related to suboptimal care, and likewise for discordant conditions. A further characterization and quantification of the multiple factors that combine for a condition's relationship with care goal achievement,

including and beyond concordance and discordance will provide more detail to design and implement multimorbidity interventions. It is imperative that we understand if and how conditions cause suboptimal care, so that we can determine when this apparent suboptimal care is actually appropriate, and when it is inappropriate and should be addressed. Understanding how conditions lead to suboptimal care will also help us design interventions to improve care.

9.5.2.2 Study Patient-Centered Outcomes

Second, as mentioned previously, this work used disease-centered, not patient-centered, outcomes. Future research should be done to assess the impact of multimorbidity on patient-centered outcomes, such as health-related quality of life, and interventions should be designed to improve these outcomes, as well as the pathophysiologic disease-centered outcomes.[15] All outcomes should be validated, sufficiently standardized for mass implementation and relevant to all patients with multimorbidity or specific subgroups.[15] Outcomes should include functional status/independence, self-perception of health and treatment burden, as these factors have identified by patients with multimorbidity as important.[53,54] Additionally, patient psychosocial and environmental factors should be considered.[36] Interventions should be designed to allow patients and their families to provide input into what care is desired and what the patient's overall health goals are, has been done in end-of-life care.[171](The intervention must take into account patient context and characteristics. [36,172] Additionally, patients should be involved in the choice of outcomes, design of the

intervention and defining the patient (and family), provider and system role in the intervention to have a truly patient-centered intervention.[172]

9.5.2.3 From Comorbidity to Multimorbidity

Finally, care goals from the multimorbid conditions should be integrated into the conceptual model and interventions developed from it. The current model focuses on diabetes care goals, and is applied to patients with diabetes. True multimorbid care would incorporate all care goals and include patients with any conditions. While it might not be realistic to use the same intervention for patients with any combination of multimorbidity, due to the extensive heterogeneity of this population, it might be possible to develop an intervention for any combination of multimorbidity that includes diabetes, considering the care goals for the patients' entire multimorbid profiles.[23] Patient-centered outcomes, and psychosocial and environmental factors, would be especially relevant with this approach. Patients would be considered as a sum of their care goals, rather than a sum of their conditions, in their personal psychosocial-environmental setting, driving patient-centered, goal-centered care.[36]

APPENDICES

Appendix 1. Chronic Condition Categories

These are the 63 chronic condition categories including diabetes, developed in Paper 1 and used in Papers 2&3, and referred to as “chronic conditions” in these papers. They are categorized below by organ system. Appendix 2 shows the ICD-9 codes that comprise these categories.

Table A1. Chronic Conditions Categories by Organ System.

Cardiac, Vascular and Pulmonary Conditions	Acute myocardial infarction in past 2 years
	Congestive heart failure
	Coronary atherosclerosis
	Peripheral atherosclerosis
	Hyperlipidemia
	Hypertension
	Conduction disorder or cardiac dysrhythmia
	Heart valve disorder
	Congenital heart disease
	Thrombosis and Embolism
	Cerebrovascular disease
	Aneurysm
	Cardiomyopathy and structural heart disease
	Non-thrombotic, non-atherosclerotic vascular disease
	Asthma or chronic obstructive pulmonary disease
	Pulmonary heart disease

Gastrointestinal Conditions	Chronic liver disease (excluding chronic hepatitis)
	Chronic hepatitis
	Diverticulosis, diverticulitis, enterocolitis, and intestinal malabsorption
	Esophageal disorder
	Chronic pancreatitis
Genitourinary and Reproductive Conditions	Chronic renal failure
	Kidney and vesicoureteral disorders (excluding renal failure)
	Benign prostatic hypertrophy
	Polycystic ovarian syndrome
	Female infertility and GU anatomic disorders (e.g. prolapse, endometriosis)
	Menopause and perimenopause
Neurologic Conditions	Paralysis
	Epilepsy
	Migraines
	Multiple sclerosis
	Organic brain problem (dementia)
	Parkinson's disease
	Other central and peripheral nervous system disorders
Musculoskeletal Conditions	Back problem
	Osteoarthritis
	Gout or other crystal arthropathy
Hematologic and Oncologic Conditions	Anemia
	Sickle cell anemia
	Malignant neoplasm

Allergy and Immunity Conditions	Allergic rhinitis
	Immunity disorder
	Lupus
	Rheumatoid arthritis
	Tuberculosis
	Human immunodeficiency virus
Mental Health Conditions	Anxiety disorders
	Depression
	Bipolar disorder
	Substance-use disorders
	Personality and psychogenic disorders
	Schizophrenia and psychotic disorders (excluding mood disorders)
	Sleep disorders
	Behavioral disorders
Endocrine Conditions	Diabetes mellitus
	Thyroid disorder
Other Conditions	Obesity
	Chronic skin ulcer
	Degenerative eye problem
	Amyloidosis
	Sarcoidosis
	Cystic fibrosis
	Non-cardiac congenital anomaly

Appendix 2. ICD-9 Diagnosis Codes for Chronic Condition Categories

These are the ICD-9 diagnosis codes for the 62 chronic condition categories (excluding diabetes) used in this study and listed in Appendix 1, categorized below by organ system.

Table A2. ICD-9 Diagnosis Codes for the 62 Categories of Chronic Conditions, excluding Diabetes

ICD-9 DIAGNOSIS CODE DESCRIPTION	ICD-9 DIAGNOSIS CODE	**Cardiac, Vascular and Pulmonary Conditions**	Acute myocardial infarction	Congestive heart failure	Coronary atherosclerosis	Peripheral atherosclerosis	Hyperlipidemia	Hypertension	Conduction disorder or cardiac dysrhythmia	Heart valve disorder	Congenital Heart Disease	Thrombosis and Embolism	Cerebrovascular disease	Aneurysm	Cardiomyopathy and Structural Heart Disease	non-thrombotic, non-atherosclerotic vascular disease	Asthma or chronic obstructive pulmonary disease	Pulmonary heart disease	**Gastrointestinal Conditions**	Chronic Liver Disease (excluding chronic hepatitis)	Chronic Hepatitis	Diverticulosis, diverticulitis, enterocolitis, intestinal malabsorption	Esophageal disorder	Chronic Pancreatitis
AMI, ANTEROLATERAL	'41000'		1																					
AMI ANTEROLATERAL- INIT	'41001'		1																					
AMI,INTEROLATERAL	'41002'		1																					
AMI ANTERIOR WALL	'41010'		1																					
AMI ANTERIOR WALL- INIT	'41011'		1																					
AMI ANTERIOR WALL;SUBSEQ	'41012'		1																					
AMI,INFEROLATERAL	'41020'		1																					
AMI INFEROLATERAL- INIT	'41021'		1																					
AMI INFEROLATERAL;SUBSEQ	'41022'		1																					
AMI INFEROPOST- UNSPEC	'41030'		1																					
AMI INFEROPOST- INITIAL	'41031'		1																					
AMI INFERIOR WALL;UNSPEC	'41040'		1																					
AMI INFERIOR WALL- INIT	'41041'		1																					
AMI INFERIOR WALL;SUBSEQ	'41042'		1																					
AMI LATERAL WALL NEC	'4105 '		1																					
AMI LATERAL NEC- UNSPEC	'41050'		1																					
AMI LATERAL NEC- INITIAL	'41051'		1																					
AMI LATERAL NEC- SUBSEQ	'41052'		1																					
TRUE POST INFARCT- INIT	'41061'		1																					
SUBENDO INFARCT- UNSPEC	'41070'		1																					
SUBENDO INFARCT- INITIAL	'41071'		1																					
SUBENDO INFARCT- SUBSEQ	'41072'		1																					

AMI NEC- UNSPECIFIED	'41080'	1		
AMI NEC- INITIAL	'41081'	1		
AMI NOS- UNSPECIFIED	'41090'	1		
AMI NOS- INITIAL	'41091'	1		
AMI NOS- SUBSEQUENT	'41092'	1		
RHEUMATIC HEART FAILURE	'39891'		1	
CONGESTIVE HEART FAILURE	'4280 '		1	
LEFT HEART FAILURE	'4281 '		1	
UNSPECIFIED SYSTOLIC HEART FAILURE	'42820'		1	
ACUTE SYSTOLIC HEART FAILURE (Begin 2002)	'42821'		1	
CHRONIC SYSTOLIC HEART FAILURE	'42822'		1	
ACUTE ON CHRONIC SYSTOLIC HEART FAILR	'42823'		1	
UNSPECIFIED DIASTOLIC HEART FAILURE	'42830'		1	
ACUTE DIASTOLIC HEART FAILURE (Begin 2002)	'42831'		1	
CHRONIC DIASTOLIC HEART FAILURE	'42832'		1	
ACUTE ON CHRONIC DIASTOLIC HEART FAILR	'42833'		1	
UNSPEC CMBINED SYST & DIAS HEART FAILR	'42840'		1	
ACUTE CMBINED SYST & DIAS HEART FAILR	'42841'		1	
CHRON CMBINED SYST & DIAS HEART FAILR	'42842'		1	
ACU CHRO COMBI SYST & DIAS HRT FAILR	'42843'		1	
HEART FAILURE NOS	'4289 '		1	
POST MI SYNDROME	'4110 '			1
INTERMED CORONARY SYND	'4111 '			1
CORONARY OCCLSN W/O MI (Begin 1989)	'41181'			1
AC ISCHEMIC HRT DIS NEC	'41189'			1
OLD MYOCARDIAL INFARCT	'412 '			1
ANGINA DECUBITUS	'4130 '			1
PRINZMETAL ANGINA	'4131 '			1
ANGINA PECTORIS NEC/NOS	'4139 '			1
CORONARY ATHEROSCLEROSIS	'4140 '			1
CORONARY ATHERO NOS	'41400'			1
CORONARY ATHERO NATIVE VESSEL	'41401'			1

CORONARY ATHERO AUTOLOG VEIN	'41402'	1		
ATHERO ART BYPAS GFT	'41404'	1		
ATHERO BYPAS GFT NOS	'41405'	1		
CORONARY ATHERO CRNRY ARTERY OF TRANS	'41406'	1		
CORONARY ATHEROSCLEROSIS- OF BYPASS GRAFT	'41407'	1		
CHR TOT OCCLUS COR ARTRY	'4142 '	1		
CHR ISCHEMIC HRT DIS NEC	'4148 '	1		
CHR ISCHEMIC HRT DIS NOS	'4149 '	1		
ASCVD	'4292 '	1		
AORTIC ATHEROSCLEROSIS	'4400 '		1	
RENAL ARTERY ATHEROSCLER	'4401 '		1	
ATHEROSCLEROS-EXTREM NOS (Begin 1992)	'44020'		1	
ATHEROSCL-EXTREM CLAUDIC (Begin 1992)	'44021'		1	
ATHEROSCL-EXTREM REST PAIN (Begin 1992)	'44022'		1	
ATHEROSCL-EXTREMITY+ULCERATION	'44023'		1	
ATHEROSCL-EXTREMITY+GANGRENE	'44024'		1	
OTH ATHEROSCLEROSIS-EXTREMITY (Begin 1993)	'44029'		1	
ATHEROSCLER OF GRAFT NOS (Begin 1994)	'44030'		1	
ATHEROSCLER OF AUTOL VEIN GRAFT (Begin 1994)	'44031'		1	
ATHEROSCLER OF NONAUTOL GRAFT	'44032'		1	
ATHEROSCLEROSIS NEC	'4408 '		1	
ATHEROSCLEROSIS NOS	'4409 '		1	
PERIPH VASCULAR DIS NEC	'44389'		1	
PERIPH VASCULAR DIS NOS	'4439 '		1	
CHR VASC INSUFF INTEST	'5571 '		1	
VASC INSUFF INTEST NOS	'5579 '		1	
DIS CARBOHYDR METAB NEC	'2718 '			1
PURE HYPERCHOLESTEROLEM	'2720 '			1
PURE HYPERGLYCERIDEMIA	'2721 '			1
MIXED HYPERLIPIDEMIA	'2722 '			1
HYPERCHYLOMICRONEMIA	'2723 '			1

HYPERLIPIDEMIA NEC/NOS	'2724 '	1		
LIPOPROTEIN DEFICIENCIES	'2725 '	1		
LIPODYSTROPHY	'2726 '	1		
LIPIDOSES	'2727 '	1		
LIPOID METABOL DIS NEC	'2728 '	1		
LIPOID METABOL DIS NOS	'2729 '	1		
DYSMETABOLIC SYNDROME X (Begin 2001)	'2777 '	1		
MALIGNANT HYPERTENSION	'4010 '		1	
BENIGN HYPERTENSION	'4011 '		1	
HYPERTENSION NOS	'4019 '		1	
MAL HYPERTEN HRT DIS NOS	'40200'		1	
MAL HYPERT HRT DIS W CHF	'40201'		1	
BEN HYPERTEN HRT DIS NOS	'40210'		1	
BENIGN HYP HRT DIS W CHF	'40211'		1	
HYPERTENSIVE HRT DIS NOS	'40290'		1	
HYPERTEN HEART DIS W CHF	'40291'		1	
MAL HYP REN W RENAL FAIL	'40301'		1	
BEN HYP REN W/O REN FAIL	'40310'		1	
BEN HYP RENAL W REN FAIL	'40311'		1	
HYP REN NOS W/O REN FAIL	'40390'		1	
HYP RENAL NOS W REN FAIL	'40391'		1	
MAL HY HT/REN W/O CHF/RF	'40400'		1	
BEN HY HT/REN W/O CHF/RF	'40410'		1	
BEN HY HT/REN W REN FAIL	'40412'		1	
BEN HYP HRT/REN W CHF & RF	'40413'		1	
HY HT/REN NOS W/O CHF/RF	'40490'		1	
HYPER HRT/REN NOS W CHF	'40491'		1	
HY HT/REN NOS W REN FAIL	'40492'		1	
HYP HT/REN NOS W CHF & RF	'40493'		1	
MAL RENOVASC HYPERTENS	'40501'		1	
MAL SECOND HYPERTEN NEC	'40509'		1	
BENIGN RENOVASC HTN	'40511'		1	
BENIGN SEC HYPERT NEC	'40519'		1	
RENOVASC HYPERTENSION	'40591'		1	
SECOND HYPERTENSION NEC	'40599'		1	
HTN ENCEPHALOPATHY	'4372 '		1	
ATRIOVENT BLOCK COMPLETE	'4260 '			1
ATRIOVENT BLOCK NOS	'42610'			1
ATRIOVENT BLOCK-1ST DEGR	'42611'			1

ATRIOVEN BLOCK-MOBITZ II	'42612'	1	
AV BLOCK-2ND DEGREE NEC	'42613'	1	
LEFT BB HEMIBLOCK	'4262 '	1	
LEFT BB BLOCK NEC	'4263 '	1	
RT BUNDLE BRANCH BLOCK	'4264 '	1	
BUNDLE BRANCH BLOCK NOS	'42650'	1	
RT BBB/LFT POST FASC BLK	'42651'	1	
RT BBB/LFT ANT FASC BLK	'42652'	1	
BILAT BB BLOCK NEC	'42653'	1	
TRIFASCICULAR BLOCK	'42654'	1	
OTHER HEART BLOCK	'4266 '	1	
ANOMALOUS AV EXCITATION	'4267 '	1	
LOWN-GANONG-LEVINE SYND	'42681'	1	
LONG QT SYNDROME	'42682'	1	
CONDUCTION DISORDER NEC	'42689'	1	
CONDUCTION DISORDER NOS	'4269 '	1	
PAROX ATRIAL TACHYCARDIA	'4270 '	1	
PAROX VENTRIC TACHYCARD	'4271 '	1	
PAROX TACHYCARDIA NOS	'4272 '	1	
ATRIAL FIBRILLATION	'42731'	1	
ATRIAL FLUTTER	'42732'	1	
VENTRICULAR FIBRILLATION	'42741'	1	
VENTRICULAR FLUTTER	'42742'	1	
PREMATURE BEATS NOS	'42760'	1	
ATRIAL PREMATURE BEATS	'42761'	1	
PREMATURE BEATS NEC	'42769'	1	
SINOATRIAL NODE DYSFUNCT	'42781'	1	
CARDIAC DYSRHYTH NEC	'42789'	1	
CARDIAC DYSRHYTHMIA NOS	'4279 '	1	
MITRAL STENOSIS	'3940 '		1
RHEUMATIC MITRAL INSUFF	'3941 '		1
MITRAL STENOSIS W INSUFF	'3942 '		1
MITRAL VALVE DIS NEC/NOS	'3949 '		1
RHEUMAT AORTIC STENOSIS	'3950 '		1
RHEUMATIC AORTIC INSUFF	'3951 '		1
RHEUM AORTIC STEN/INSUFF	'3952 '		1
RHEUM AORTIC DIS NEC/NOS	'3959 '		1
MITRAL/AORTIC STENOSIS	'3960 '		1
MITRAL STENOS/AORT INSUF	'3961 '		1
MITRAL INSUF/AORT STENOS	'3962 '		1
MITRAL/AORTIC VAL INSUFF	'3963 '		1

MITR/AORTIC MULT INVOLV	'3968 '	1	
MITRAL/AORTIC V DIS NOS	'3969 '	1	
TRICUSPID VALVE DISEASE	'3970 '	1	
RHEUM PULMON VALVE DIS	'3971 '	1	
MITRAL VALVE DISORDER	'4240 '	1	
AORTIC VALVE DISORDER	'4241 '	1	
NONRHEUM TRICUSP VAL DIS	'4242 '	1	
PULMONARY VALVE DISORDER	'4243 '	1	
ENDOCARDITIS NOS	'42490'	1	
ENDOCARDITIS NEC	'42499'	1	
COMMON TRUNCUS	'7450 '		1
COMPL TRANSP GREAT VES	'74510'		1
DOUBLE OUTLET RT VENTRIC	'74511'		1
CORRECT TRANSP GRT VES	'74512'		1
TRANSPOS GREAT VESS NEC	'74519'		1
TETRALOGY OF FALLOT	'7452 '		1
COMMON VENTRICLE	'7453 '		1
VENTRICULAR SEPT DEFECT	'7454 '		1
SECUNDUM ATRIAL SEPT DEF	'7455 '		1
OSTIUM PRIMUM DEFECT	'74561'		1
ENDOCARD CUSH DEF NEC	'74569'		1
SEPTAL CLOSURE ANOM NEC	'7458 '		1
CONG PULMON VALV ATRESIA	'74601'		1
CONG PULM VALVE STENOS	'74602'		1
PULM VALVE ANOM NEC	'74609'		1
CONG TRICUSP ATRES/STEN	'7461 '		1
EBSTEIN-s ANOMALY	'7462 '		1
CONG AORTA VALV STENOSIS	'7463 '		1
CONG AORTA VALV INSUFFIC	'7464 '		1
CONGEN MITRAL STENOSIS	'7465 '		1
CONG MITRAL INSUFFICIENC	'7466 '		1
HYPOPLAS LEFT HEART SYND	'7467 '		1
CONG SUBAORTIC STENOSIS	'74681'		1
OBSTRUCT HEART ANOM NEC	'74684'		1
CORONARY ARTERY ANOMALY	'74685'		1
MALPOSITION OF HEART	'74687'		1
CONG HEART ANOMALY NEC	'74689'		1
CONG HEART ANOMALY NOS	'7469 '		1
PATENT DUCTUS ARTERIOSUS	'7470 '		1

COARCTATION OF AORTA	'74710'	1		
INTERRUPT OF AORTIC ARCH	'74711'	1		
CONG ANOM OF AORTA NOS	'74720'	1		
ANOMALIES OF AORTIC ARCH	'74721'	1		
AORTIC ATRESIA/STENOSIS	'74722'	1		
CONG ANOM OF AORTA NEC	'74729'	1		
PULMONARY ARTERY ANOM	'7473 '	1		
GREAT VEIN ANOMALY NOS	'74740'	1		
TOT ANOM PULM VEN CONNEC	'74741'	1		
PART ANOM PULM VEN CONN	'74742'	1		
GREAT VEIN ANOMALY NEC	'74749'	1		
UMBILICAL ARTERY ABSENCE	'7475 '	1		
UNSPEC PERIPH VASCULAR ANOM (Begin 1993)	'74760'	1		
GI VESSEL ANOMALY	'74761'	1		
RENAL VESSEL ANOMALY	'74762'	1		
UP LIMB VESSEL ANOMALY	'74763'	1		
LOWER LIMB VESSEL ANOMALY (Begin 1993)	'74764'	1		
OTH SPEC PERIPH VASCULAR ANOM (Begin 1993)	'74769'	1		
CEREBROVASCULAR ANOMALY	'74781'	1		
SPINAL VESSEL ANOMALY	'74782'	1		
CIRCULATORY ANOMALY NEC	'74789'	1		
CIRCULATORY ANOMALY NOS	'7479 '	1		
THROMBOANGIIT OBLITERANS	'4431 '		1	
ABD AORTIC EMBOLISM	'4440 '		1	
THORACIC AORTIC EMBOLISM	'4441 '		1	
UPPER EXTREMITY EMBOLISM	'44421'		1	
LOWER EXTREMITY EMBOLISM	'44422'		1	
ILIAC ARTERY EMBOLISM	'44481'		1	
ARTERIAL EMBOLISM NEC	'44489'		1	
ARTERIAL EMBOLISM NOS	'4449 '		1	
SUBARACHNOID HEMORRHAGE	'430 '			1
INTRACEREBRAL HEMORRHAGE	'431 '			1
SUBDURAL HEMORRHAGE	'4321 '			1
INTRACRANIAL HEMORR NOS	'4329 '			1
BASILAR ART OCCLUS W/O INFARCT (Begin 1993)	'43300'			1

CAROTID ARTERY OCCLUSION (End 1993)	'4331 '	1
CAROTID ART OCCLUS W/O INFARCT (Begin 1993)	'43310'	1
CAROTID ART OCCLUS W/CEREB INFARCT	'43311'	1
VERTEBRAL ART OCCLUS W/O INFARCT (Begin 1993)	'43320'	1
VERTEB ART OCCLUS W/CEREB INFARCT (Begin 1993)	'43321'	1
MULT PRECEREB OCCLUS W/O INFARCT (Begin 1993)	'43330'	1
MULT PRECEREB OCCLUS W/ INFARCT (Begin 1993)	'43331'	1
PRECEREB OCCLUS NOS W/O INFARCT	'43391'	1
CEREBRAL THROMBOSIS	'4340 '	1
CEREB THROMBOSIS W/O INFARCT (Begin 1993)	'43400'	1
CEREB THROMBOSIS W/ INFARCTION (Begin 1993)	'43401'	1
CEREB EMBOLISM W/O INFARCTION (Begin 1993)	'43410'	1
CEREB EMBOLISM W/ INFARCTION (Begin 1993)	'43411'	1
CEREBR ART OCCLUS NOS	'4349 '	1
CEREBR ART OCCLUS NOS W/O INFARCT (Begin 1993)	'43490'	1
CEREBR ART OCCLUS NOS W/ INFARCT	'43491'	1
BASILAR ARTERY SYNDROME	'4350 '	1
VERTEBRAL ARTERY SYNDROM	'4351 '	1
SUBCLAVIAN STEAL SYNDROM	'4352 '	1
VERTEBROBASILAR ART SYNDR (Begin 1995)	'4353 '	1
TRANS CEREB ISCHEMIA NEC	'4358 '	1
TRANS CEREB ISCHEMIA NOS	'4359 '	1
CVA	'436 '	1
CEREBRAL ATHEROSCLEROSIS	'4370 '	1
AC CEREBROV INSUF NOS	'4371 '	1
NONRUPT CEREBRAL ANEURYM	'4373 '	1
CEREBRAL ARTERITIS	'4374 '	1
MOYAMOYA DISEASE	'4375 '	1

TRANSIENT GLOBAL AMNESIA	'4377 '	1	
CEREBROVASC DISEASE NEC	'4378 '	1	
CEREBROVASC DISEASE NOS	'4379 '	1	
LATE EFF CEREBROVASC DIS	'438 '	1	
LATE EFF CVD COGNITIVE DEF (Begin 1997)	'4380 '	1	
LATE EFF CVD SP DEF NOS	'43810'	1	
LATE EFF CVD APHASIA.	'43811'	1	
LATE EFF CVD DYSPHASIA.	'43812'	1	
LATE EFF CVD SP DEF NEC	'43819'	1	
LATE EFF CVD HEMIPLEG NOS	'43820'	1	
LATE EFF CVD HEMIPLEG DOM (Begin 1997)	'43821'	1	
LATE EFF CVD HEMIPLEG NONDOM (Begin 1997)	'43822'	1	
LATE EFF CVD OTH PARALY SYNDR NOS (Begin 1997)	'43850'	1	
ALTERNATIVE OF SENSATIONS (Begin 2002)	'4386 '	1	
DISTURBANCES OF VERSION	'4387 '	1	
OT LATE EFF CVD APRAXIA	'43881'	1	
OT LATE EFF CVD DYSPHAGIA	'43882'	1	
FACIAL WEAKNESS	'43883'	1	
ATAXIA (Begin 2002)	'43884'	1	
VERTIGO (Begin 2002)	'43885'	1	
OT LATE EFFECTS OF CVD	'43889'	1	
UNSPEC LATE EFFECTS OF CVD (Begin 1997)	'4389 '	1	
ANEURYSM- HEART (WALL)	'41410'		1
CORONARY VESSEL ANEURYSM	'41411'		1
DISSECTION OF CORONARY ARTERY (Begin 2002)	'41412'		1
ANEURYSM OF HEART NEC	'41419'		1
DISSECTING AORTIC ANEURYSM NOS (Begin 1994)	'44100'		1
DISSECTING THORACIC ANEURYSM (Begin 1994)	'44101'		1
DISSECTING ABDOM ANEURYSM (Begin 1994)	'44102'		1
DISSECTING THORACOABD ANEURYSM (Begin 1994)	'44103'		1
RUPTUR THORACIC ANEURYSM	'4411 '		1
THORACIC AORTIC ANEURYSM	'4412 '		1

RUPT ABD AORTIC ANEURYSM	'4413 '	1		
ABDOM AORTIC ANEURYSM	'4414 '	1		
RUPT THORACO-ABDOM AORTIC ANEURYSM	'4416 '	1		
THORACO-ABDOM AORTIC ANEURYSM (Begin 1993)	'4417 '	1		
AORTIC ANEURYSM NOS	'4419 '	1		
UPPER EXTREMITY ANEURYSM	'4420 '	1		
DISSECTION OF CAROTID ARTERY (Begin 2002)	'44321'	1		
DISSECTION OF ILIAC ARTERY (Begin 2002)	'44322'	1		
DISSECTION OF RENAL ARTERY (Begin 2002)	'44323'	1		
DISSECTION OF VARTEBRAL ARTERY (Begin 2002)	'44324'	1		
DISSECTION OF OTHER ARTERY (Begin 2002)	'44329'	1		
HYPERTR OBSTR CARDIOMYOP	'4251 '		1	
ENDOCARD FIBROELASTOSIS	'4253 '		1	
PRIM CARDIOMYOPATHY NEC	'4254 '		1	
ALCOHOL CARDIOMYOPATHY	'4255 '		1	
METABOLIC CARDIOMYOP	'4257 '		1	
CARDIOMYOPATH IN OTH DIS	'4258 '		1	
SEC CARDIOMYOPATH NOS	'4259 '		1	
MYOCARDITIS NOS	'4290 '		1	
MYOCARDIAL DEGENERATION	'4291 '		1	
CARDIOMEGALY	'4293 '		1	
HRT DIS POSTCARDIAC SURG	'4294 '		1	
CHORDAE TENDINAE RUPTURE	'4295 '		1	
PAPILLARY MUSCLE RUPTURE	'4296 '		1	
ACQ CARDIAC SEPTL DEFECT	'42971'		1	
HYPERKINETIC HEART DIS	'42982'		1	
TAKOTSUBO SYNDROME	'42983'		1	
ILL-DEFINED HRT DIS NEC	'42989'		1	
HEART DISEASE NOS	'4299 '		1	
RAYNAUD-s SYNDROME	'4430 '			1
ANGIOPATHY IN OTHER DIS	'44381'			1
ERYTHROMELALGIA	'44382'			1
POLYARTERITIS NODOSA	'4460 '			1
HYPERSENSIT ANGIITIS NOS	'44620'			1

GOODPASTURE-S SYNDROME	'44621'	1	
HYPERSENSIT ANGIITIS NEC	'44629'	1	
WEGENER-s GRANULOMATOSIS	'4464 '	1	
GIANT CELL ARTERITIS	'4465 '	1	
THROMBOT MICROANGIOPATHY	'4466 '	1	
ACQ ARTERIOVEN FISTULA	'4470 '	1	
STRICTURE OF ARTERY	'4471 '	1	
RUPTURE OF ARTERY	'4472 '	1	
RENAL ARTERY HYPERPLASIA	'4473 '	1	
CELIAC ART COMPRESS SYN	'4474 '	1	
ARTERITIS NOS	'4476 '	1	
ARTERIAL DISEASE NEC	'4478 '	1	
ARTERIAL DISEASE NOS	'4479 '	1	
BUDD-CHIARI SYNDROME	'4530 '	1	
THROMBOPHLEBITIS MIGRANS	'4531 '	1	
VENA CAVA THROMBOSIS	'4532 '	1	
RENAL VEIN THROMBOSIS	'4533 '	1	
DVT/EMBLSM LOW EXT NOS	'45340'	1	
DVT/EMB PROX LOWER EXT	'45341'	1	
DVT/EMB DISTAL LOWER EXT	'45342'	1	
VENOUS THROMBOSIS NEC	'4538 '	1	
VENOUS THROMBOSIS NOS	'4539 '	1	
POSTMASTECT LYMPHEDEMA	'4570 '	1	
OTHER LYMPHEDEMA	'4571 '	1	
LYMPHANGITIS	'4572 '	1	
NONINFECT LYMPH DIS NEC	'4578 '	1	
NONINFECT LYMPH DIS NOS	'4579 '	1	
ALPHA-1-ANTITRYPSIN DEF	'2734 '		1
SIMPLE CHR BRONCHITIS	'4910 '		1
MUCOPURUL CHR BRONCHITIS	'4911 '		1
OBS CHR BRNC W/O ACT EXA	'49120'		1
OBS CHR BRNC W ACT EXA	'49121'		1
OBS CHR BRONC W AC BRONC (Begin 2004)	'49122'		1
CHRONIC BRONCHITIS NEC	'4918 '		1
CHRONIC BRONCHITIS NOS	'4919 '		1
EMPHYSEMATOUS BLEB	'4920 '		1
EMPHYSEMA NEC	'4928 '		1
EXT ASTHMA W/O STAT ASTH	'49300'		1

EXT ASTHMA W STATUS ASTH	'49301'	1		
EXT ASTHMA W/ ACUTE EXACERBATION (Begin 2000)	'49302'	1		
INT ASTHMA W/O STAT ASTH	'49310'	1		
INT ASTHMA W STATUS ASTH	'49311'	1		
INT ASTHMA W/ ACUTE EXACERBATION (Begin 2000)	'49312'	1		
CH OB ASTH W/O STAT ASTH	'49320'	1		
CH OB ASTHMA W STAT ASTH	'49321'	1		
CH OB ASTHMA W/ACUTE EXACERBATION (Begin 2000)	'49322'	1		
EXERCISE INDUCED BRONCHOSPASM (Begin 2003)	'49381'	1		
COUGH VARIANT ASTHMA	'49382'	1		
ASTHMA W/O STATUS ASTHM	'49390'	1		
ASTHMA W/ STATUS ASTHMAT	'49391'	1		
ASTHMA W/ ACUTE EXACERBATION (Begin 2000)	'49392'	1		
BRONCHIECTASIS (End 2000)	'494 '	1		
BRONCHIECTASIS W/O ACUTE EXACERBATN (Begin 2000)	'4940 '	1		
BRONCHIECTASIS W/ACUTE EXACERBATION (Begin 2000)	'4941 '	1		
CHR AIRWAY OBSTRUCT NEC	'496 '	1		
ASBESTOSIS	'501 '	1		
Other respiratory abnormalities	'78609'	1		
Other diseases of lung, not elsewhere classified	'51889'	1		
ACUTE COR PULMONALE	'4150 '		1	
PULMON EMBOLISM/INFARCT	'4151 '		1	
SEPTIC PULMONARY EMBOLSM	'41512'		1	
OTHER PULMON EMBOL INFARCT	'41519'		1	
PRIM PULM HYPERTENSION	'4160 '		1	
CHR PULMON HEART DIS NEC	'4168 '		1	
CHR PULMON HEART DIS NOS	'4169 '		1	
ARTERIOVEN FISTU PUL VES	'4170 '		1	
PULMON CIRCULAT DIS NEC	'4178 '		1	
CIRRHOSIS OF LIVER NOS	'5715 '			1
BILIARY CIRRHOSIS	'5716 '			1
CHRONIC LIVER DIS NEC	'5718 '			1
CHRONIC LIVER DIS NOS	'5719 '			1
CHR PASSIV CONGEST LIVER	'5730 '			1
LIVER DISORDERS NEC	'5738 '			1

LIVER DISORDER NOS	'5739 '	1			
ALCHOL FATTY LIVER	'5710 '		1		
ACUTE ALCOHOL HEPATITIS	'5711 '		1		
ALCOHOL CIRRHOSIS LIVER	'5712 '		1		
ALCOHOL LIVER DAMAGE UNSPEC	'5713 '		1		
CHRONIC HEPATITIS NOS	'57140'		1		
CHR PERSISTENT HEPATITIS	'57141'		1		
CHRONIC HEPATITIS NEC	'57149'		1		
HEPATITIS IN VIRAL DIS	'5731 '		1		
HEPATITIS NOS	'5733 '		1		
REG ENTERITIS- SM INTEST	'5550 '			1	
REG ENTERITIS- LG INTEST	'5551 '			1	
REG ENTERIT SM/LG INTEST	'5552 '			1	
REGIONAL ENTERITIS NOS	'5559 '			1	
ULCERATIVE ENTEROCOLITIS	'5560 '			1	
ULCERATIVE ILEOCOLITIS	'5561 '			1	
ULCERATIVE PROCTITIS	'5562 '			1	
ULCERATIVE PROCTOSIGMOIDITIS	'5563 '			1	
PSEUDOPOLYPOSIS OF COLON (Begin 1994)	'5564 '			1	
LEFT SIDED ULCERATIVE COLITIS (Begin 1994)	'5565 '			1	
UNIVERSAL ULCERATIVE COLITIS (Begin 1994)	'5566 '			1	
OTHER ULCERATIVE COLITIS	'5568 '			1	
ULCERATIVE COLITIS NOS	'5569 '			1	
DVRTCLO SML INT (W/O HMRG) (Begin 1980)	'56200'			1	
DVRTCLI SML INT (W/O HMRG)	'56201'			1	
DVRTCLO SML INT W HMRHG	'56202'			1	
DVRTCLO COLON (W/O HMRHG) (Begin 1980)	'56210'			1	
DVRTCLI COLON (W/O HMRHG) (Begin 1980)	'56211'			1	
DVRTCLO COLON W HMRHG	'56212'			1	
DVRTCLI COLON W HMRHG	'56213'			1	
CELIAC DISEASE	'5790 '			1	
TROPICAL SPRUE	'5791 '			1	
BLIND LOOP SYNDROME	'5792 '			1	
INTEST MALABSORPTION NEC	'5798 '			1	
INTEST MALABSORPTION NOS	'5799 '			1	
Constipation, unspecified	'56400'			1	

ACHALASIA & CARDIOSPASM	'5300 '	1	
OTH ESOPHAGITIS	'53019'	1	
ULCER OF ESOPHAGUS WITHOUT BLEEDING	'53020'	1	
ULCER OF ESOPHAGUS WITH BLEEDING (Begin 2003)	'53021'	1	
ESOPHAGEAL STRICTURE	'5303 '	1	
PERFORATION OF ESOPHAGUS	'5304 '	1	
DYSKINESIA OF ESOPHAGUS	'5305 '	1	
ACQ ESOPHAG DIVERTICULUM	'5306 '	1	
ESOPHAGEAL DISORDER NEC	'5308 '	1	
ESOPHAGEAL LEUKOPLAKIA	'53083'	1	
TRACHEOESOPHAGEAL FISTULA	'53084'	1	
BARRETTS ESOPHAGUS	'53085'	1	
OTH SPEC DISORDER ESOPHAGUS	'53089'	1	
Esophageal reflux	'53081'	1	
CHRONIC PANCREATITIS	'5771 '		1
PANCREATIC DISEASE NEC	'5778 '		1
PANCREATIC STEATORRHEA	'5794 '		1

ICD-9 DIAGNOSIS CODE DESCRIPTION	ICD-9 DIAGNOSIS CODE	**Genitourinary and Reproductive Conditions**	Chronic renal failure	Kidney and Vesicoureteral Disorders (excluding renal failure)	Benign prostatic hypertrophy (BPH)	Polycystic ovarian syndrome	Female infertility and GU anatomic disorders (eg prolapse, endometriosis)	Menopause and perimenoapuse	**Neurologic Conditions**	Paralysis	Epilepsy	Migraines	Multiple sclerosis	Organic brain problem (dementia)	Parkinson's disease	Other central and peripheral nervous system disorders	**Musculoskeletal Conditions**	Back problem	Osteoarthritis	Gout or other crystal arthropathy
CHRONIC RENAL FAILURE (End 2005)	'585 '		1																	
CHR KIDNEY DIS STAGE III (Begin 2005)	'5853 '		1																	
CHR KIDNEY DIS STAGE IV (Begin 2005)	'5854 '		1																	
CHRON KIDNEY DIS STAGE V (Begin 2005)	'5855 '		1																	
END STAGE RENAL DISEASE (Begin 2005)	'5856 '		1																	
CHRONIC KIDNEY DIS NOS (Begin 2005)	'5859 '		1																	
RENAL DIALYSIS ENCOUNTER	'V560 '		1																	
FIT ADJUST DIALYSIS CATHET	'V561 '		1																	
FIT ADJUST PERITON DIAL CATH	'V562 '		1																	
PROLIFERAT NEPHRITIS NOS	'5830 '			1																
MEMBRANOUS NEPHRITIS NOS	'5831 '			1																
MEMBRANOPROLIF NEPHR NOS	'5832 '			1																
RAPIDLY PROG NEPHRIT NOS	'5834 '			1																
NEPHRITIS NOS IN OTH DIS	'58381'			1																
NEPHRITIS NEC	'58389'			1																
NEPHRITIS NOS	'5839 '			1																
RENAL OSTEODYSTROPHY	'5880 '			1																
NEPHROGEN DIABETES INSIP	'5881 '			1																
IMPAIRED RENAL FUNCT NEC (End 2004)	'5888 '			1																
SEC HYPERPARATHYRD-RENAL	'58881'			1																
IMPAIR REN FUNCT DIS NEC (Begin 2004)	'58889'			1																
IMPAIRED RENAL FUNCT NOS	'5889 '			1																
HYPERTROPHY OF KIDNEY	'5931 '			1																
CYST OF KIDNEY- ACQUIRED	'5932 '			1																
STRICTURE OF URETER	'5933 '			1																
URETERIC OBSTRUCTION NEC	'5934 '			1																
HYDROURETER	'5935 '			1																
VESICOURETERAL REFLUX W/O NEPHRO	'59370'			1																
VESICOURETER REFLUX W UNILAT NEPHROP (Begin 1994)	'59371'			1																

VESICOURETER REFLUX W BILAT NEPHROP (Begin 1994)	'59372'	1			
VESICOURETER REFLUX NOS (Begin 1994)	'59373'	1			
RENAL & URETERAL DIS NEC	'59389'	1			
RENAL & URETERAL DIS NOS	'5939 '	1			
Hematuria	'5997'	1			
HYPERTROPHY (BENIGN) OF PROSTATE WITHOUT URIN (Begin 2003)	'60000'		1		
HYPERTROPHY (BENIGN) OF PROSTATE WITH URINARY (Begin 2003)	'60001'		1		
NODULAR PROSTATE WITHOUT URINARY OBSTRUCTION (Begin 2003)	'60010'		1		
NODULAR PROSTATE WITH URINARY OBSTRUCTION (Begin 2003)	'60011'		1		
BENIGN LOCALIZED HYPERPLASIA OF PROSTATE WITH (Begin 2003)	'60020'		1		
BENIGN LOCALIZED HYPERPLASIA OF PROSTATE WITH (Begin 2003)	'60021'		1		
HYPERPLASIA OF PROSTATE-UNSPECIFIED- WITHOUT (Begin 2003)	'60090'		1		
HYPERPLASIA OF PROSTATE-UNSPECIFIED- WITH UR (Begin 2003)	'60091'		1		
POLYCYSTIC OVARIES	'2564 '			1	
HYPERESTROGENISM	'2560 '				1
OVARIAN HYPERFUNC NEC	'2561 '				1
POSTABLATIV OVARIAN FAIL	'2562 '				1
OTHER OVARIAN FAILURE (Begin 2001)	'25639'				1
OVARIAN DYSFUNCTION NEC	'2568 '				1
OVARIAN DYSFUNCTION NOS	'2569 '				1
UTERINE ENDOMETRIOSIS	'6170 '				1
OVARIAN ENDOMETRIOSIS	'6171 '				1
TUBAL ENDOMETRIOSIS	'6172 '				1
PELV PERIT ENDOMETRIOSIS	'6173 '				1
VAGINAL ENDOMETRIOSIS	'6174 '				1
INTESTINAL ENDOMETRIOSIS	'6175 '				1
ENDOMETRIOSIS IN SCAR	'6176 '				1
ENDOMETRIOSIS NEC	'6178 '				1
ENDOMETRIOSIS NOS	'6179 '				1
PROLAPSE OF VAGINAL WALL (End 2004)	'6180 '				1
VAGINAL WALL PROLPSE NOS	'61800'				1
CYSTOCELE, MIDLINE (Begin 2004)	'61801'				1
CYSTOCELE, LATERAL (Begin 2004)	'61802'				1
URETHROCELE (Begin 2004)	'61803'				1
RECTOCELE (Begin 2004)	'61804'				1
PERINEOCELE (Begin 2004)	'61805'				1
CYSTOURETHROCELE (Begin 2004)	'61809'				1
UTERINE PROLAPSE	'6181 '				1
UTEROVAG PROLAPS-INCOMPL	'6182 '				1
UTEROVAG PROLAPS-COMPLET	'6183 '				1
UTERVAGINAL PROLAPSE NOS	'6184 '				1

POSTOP VAGINAL PROLAPSE	'6185 '	1		
VAGINAL ENTEROCELE	'6186 '	1		
GENITAL PROLAPSE NEC (End 2004)	'6188 '	1		
INCOMPTNCE RECTOVAG TISS	'61882'	1		
PELVIC MUSCLE WASTING (Begin 2004)	'61883'	1		
GENITAL PROLAPSE NEC (Begin 2004)	'61889'	1		
GENITAL PROLAPSE NOS	'6189 '	1		
PREMENOPAUSE MENORRHAGIA	'6270 '	1		
INFERTILITY-ANOVULATION	'6280 '	1		
INFERTILITY-TUBAL ORIGIN	'6282 '	1		
INFERTILITY-UTERINE ORIG	'6283 '	1		
FEMALE INFERTILITY NEC	'6288 '	1		
FEMALE INFERTILITY NOS	'6289 '	1		
FEMALE GENITAL DIS NEC	'6298 '	1		
FEMALE GENITAL DISOR NEC (Begin 2006)	'62989'	1		
FEMALE GENITAL DIS NOS	'6299 '	1		
Excessive or frequent menstruation	'6262'	1		
Irregular menstrual cycle	'6264'	1		
PREMATURE MENOPAUSE (Begin 2001)	'25631'		1	
POSTMENOPAUSAL BLEEDING	'6271 '		1	
FEMALE CLIMACTERIC STATE	'6272 '		1	
ATROPHIC VAGINITIS	'6273 '		1	
ARTIFIC MENOPAUSE STATES	'6274 '		1	
MENOPAUSAL DISORDER NEC	'6278 '		1	
MENOPAUSAL DISORDER NOS	'6279 '		1	
FLACCID HEMIPLEGIA (End 1994)	'3420 '			1
FLACCID HEMIPLEG- UNSPEC SIDE	'34200'			1
FLACCID HEMIPLEG- NONDOMINANT SIDE	'34202'			1
SPASTIC HEMIPLEGIA (End 1994)	'3421 '			1
SPASTIC HEMIPLEG- UNSPEC SIDE	'34210'			1
SPASTIC HEMIPLEG- DOMINANT SIDE	'34211'			1
SPASTIC HEMIPLEG- NONDOMINANT SIDE	'34212'			1
OTH SPEC HEMIPLEGIA- DOMINANT SIDE	'34281'			1
OTH SPEC HEMIPLEGIA- NONDOM SIDE	'34282'			1
HEMIPLEGIA NOS (End 1994)	'3429 '			1
UNSPEC HEMIPLEGIA- UNSPEC SIDE	'34290'			1
UNSPEC HEMIPLEGIA- DOMINANT SIDE	'34291'			1
UNSPEC HEMIPLEGIA- NONDOM SIDE	'34292'			1
CONGENITAL DIPLEGIA	'3430 '			1
CONGENITAL HEMIPLEGIA	'3431 '			1
CONGENITAL QUADRIPLEGIA	'3432 '			1
CEREBRAL PALSY NEC	'3438 '			1
CEREBRAL PALSY NOS	'3439 '			1
QUADRIPLEGIA NOS (End 1994)	'3440 '			1
QUADRIPLEGIA- NOS (Begin 1994)	'34400'			1
QUADRIPLEGIA- C1-C4 COMPLETE	'34401'			1
QUADRIPLEGIA- C1-C4 INCOMPLETE	'34402'			1
QUADRIPLEGIA- C5-C7 COMPLETE	'34403'			1
QUADRIPLEGIA- C5-C7 INCOMPLETE	'34404'			1
QUADRIPLEGIA- OTHER (Begin 1994)	'34409'			1

PARAPLEGIA NOS	'3441 '	1					
DIPLEGIA OF UPPER LIMBS	'3442 '	1					
MONOPLEGIA LEG NOS (Begin 1994)	'34430'	1					
MONOPLEGIA ARM NOS (Begin 1994)	'34440'	1					
MONOPLEGIA ARM AFFECT DOM SIDE	'34441'	1					
MONOPLEGIA ARM AFFECT NONDOM SIDE (Begin 1994)	'34442'	1					
CAUDA EQUINA SYND NOS	'34460'	1					
OTH SPEC PARALYTIC SYNDROMES	'34489'	1					
PARALYSIS NOS	'3449 '	1					
GEN NONCV EP W/O INTR EP (Begin 1989)	'34500'		1				
GEN NONCONV EP W INTR EP (Begin 1989)	'34501'		1				
GEN CNV EPIL W/O INTR EP (Begin 1989)	'34510'		1				
GEN CNV EPIL W INTR EPIL (Begin 1989)	'34511'		1				
PETIT MAL STATUS	'3452 '		1				
GRAND MAL STATUS	'3453 '		1				
PSYMOTR EPIL W/O INT EPI (Begin 1989)	'34540'		1				
PSYMOTR EPIL W INTR EPIL (Begin 1989)	'34541'		1				
PART EPIL W/O INTR EPIL (Begin 1989)	'34550'		1				
PART EPIL W INTR EPIL (Begin 1989)	'34551'		1				
INF SPASM W/O INTR EPIL (Begin 1989)	'34560'		1				
EPIL PAR CONT W/O INT EP (Begin 1989)	'34570'		1				
EPILEPSY NEC (Begin 1980, End 1989)	'3458 '		1				
EPILEP NOS W/O INTR EPIL (Begin 1989)	'34590'		1				
EPILEPSY NOS W INTR EPIL (Begin 1989)	'34591'		1				
Other convulsions	'78039'		1				
TENSION HEADACHE	'30781'			1			
CLASSICAL MIGRAINE	'3460 '			1			
CLASSICAL MIGR-NOT INTR (Begin 1992)	'34600'			1			
CLASSICAL MIGR-INTRACT (Begin 1992)	'34601'			1			
COMMON MIGR-NOT INTR (Begin 1992)	'34610'			1			
COMMON MIGR-INTRACT (Begin 1992)	'34611'			1			
VARIANTS OF MIGRAINE	'3462 '			1			
VARIANTS OF MIGR-NOT INTR (Begin 1992)	'34620'			1			
VARIANTS OF MIGR-INTRACT (Begin 1992)	'34621'			1			
MIGR NEC-NOT INTR (Begin 1992)	'34680'			1			
MIGR NEC-INTRACT (Begin 1992)	'34681'			1			
MIGRAINE NOS (Begin 1980, End 1992)	'3469 '			1			
MIGRAINE NOS-NOT INTR (Begin 1992)	'34690'			1			
MIGRAINE NOS-INTRACT (Begin 1992)	'34691'			1			
MULTIPLE SCLEROSIS	'340 '				1		
SENILE DEMENTIA UNCOMP	'2900 '					1	
PRESENILE DEMENTIA	'29010'					1	
PRESENILE DELIRIUM	'29011'					1	
PRESENILE DEPRESSION	'29013'					1	
SENILE DELUSION	'29020'					1	
SENILE DEPRESSIVE	'29021'					1	
SENILE DELIRIUM	'2903 '					1	
ARTERIOSCLER DEMENT NOS	'29040'					1	
ARTERIOSCLER DELIRIUM	'29041'					1	

ARTERIOSCLER DEPRESSIVE	'29043'	1		
SENILE PSYCHOT COND NOS	'2909 '	1		
ORGANIC HALLUCINOSIS SYN	'29382'	1		
ORGANIC AFFECTIVE SYND	'29383'	1		
ORGANIC ANXIETY SYND OCT96--	'29384'	1		
AMNESTIC SYNDROME	'2940 '	1		
DEMENTIA IN OTH DISEASES W0 BEHAVRAL OCT00-	'29410'	1		
DEMENTIA IN OTH DISEASES WBEHAVIORAL OCT00-	'29411'	1		
ORGANIC BRAIN SYND NEC	'2948 '	1		
ORGANIC BRAIN SYND NOS	'2949 '	1		
FRONTAL LOBE SYNDROME	'3100 '	1		
ORGANIC PERSONALITY SYND	'3101 '	1		
POSTCONCUSSION SYNDROME	'3102 '	1		
NONPSYCHOT BRAIN SYN NOS	'3109 '	1		
SEVERE MENTAL RETARDAT	'3181 '	1		
PROFOUND MENTAL RETARDAT	'3182 '	1		
ALZHEIMERS DISEASE	'3310 '	1		
SENILE DEGENERAT BRAIN	'3312 '	1		
DEMENTIA WITH LEWY BODIES	'33182'	1		
SENILITY WITHOUT MENTION OF PSYCHOSIS	'797 '	1		
PARALYSIS AGITANS	'3320 '		1	
OTH ENTEROVIRAL CNS DIS	'048 '			1
LATE EFFECT ACUTE POLIO	'138 '			1
LEUKODYSTROPHY	'3300 '			1
CEREB DEGEN IN CHILD NEC	'3308 '			1
COMMUNICAT HYDROCEPHALUS	'3313 '			1
OBSTRUCTIV HYDROCEPHALUS	'3314 '			1
NORML PRESSURE HYDROCEPH	'3315 '			1
CEREB DEGEN IN OTH DIS	'3317 '			1
MILD COGNITIVE IMPAIREMT (Begin 2006)	'33183'			1
CEREB DEGENERATION NEC	'33189'			1
CEREB DEGENERATION NOS	'3319 '			1
SECONDARY PARKINSONISM	'3321 '			1
DEGEN BASAL GANGLIA NEC	'3330 '			1
TREMOR NEC	'3331 '			1
MYOCLONUS	'3332 '			1
TICS OF ORGANIC ORIGIN	'3333 '			1
HUNTINGTON-S CHOREA	'3334 '			1
CHOREA NEC	'3335 '			1
IDIOPAT TORSION DYSTONIA	'3336 '			1
SYMPTOM TORSION DYSTONIA	'3337 '			1
ATHETOID CEREBRAL PALSY (Begin 2006)	'33371'			1
BLEPHAROSPASM	'33381'			1
OROFACIAL DYSKINESIA	'33382'			1
SPASMODIC TORTICOLLIS	'33383'			1
ORGANIC WRITERS CRAMP	'33384'			1
SUBAC DYSKINESA D/T DRUG (Begin 2006)	'33385'			1

FRAGM TORSION DYSTON NEC	'33389'	1
EXTRAPYRAMIDAL DIS NOS	'33390'	1
STIFF-MAN SYNDROME	'33391'	1
RESTLESS LEGS SYNDROME (Begin 2006)	'33394'	1
EXTRAPYRAMIDAL DIS NEC	'33399'	1
FRIEDREICH-S ATAXIA	'3340 '	1
HERED SPASTIC PARAPLEGIA	'3341 '	1
PRIMARY CEREBELLAR DEGEN	'3342 '	1
CEREBELLAR ATAXIA NEC	'3343 '	1
CEREBEL ATAX IN OTH DIS	'3344 '	1
SPINOCEREBELLAR DIS NEC	'3348 '	1
SPINOCEREBELLAR DIS NOS	'3349 '	1
WERDNIG-HOFFMANN DISEASE	'3350 '	1
SPINAL MUSCL ATROPHY NOS	'33510'	1
AMYOTROPHIC SCLEROSIS	'33520'	1
PRIM LATERAL SCLEROSIS	'33524'	1
MOTOR NEURON DISEASE NEC	'33529'	1
ANT HORN CELL DIS NOS	'3359 '	1
SYRINGOMYELIA	'3360 '	1
VASCULAR MYELOPATHIES	'3361 '	1
COMB DEG CORD IN OTH DIS	'3362 '	1
MYELOPATHY IN OTH DIS	'3363 '	1
MYELOPATHY NEC	'3368 '	1
SPINAL CORD DISEASE NOS	'3369 '	1
IDIOPATH AUTO NEUROPATHY (end 2008)	'3370 '	1
AUT NEUROPTHY IN OTH DIS	'3371 '	1
REFLEX SYMPATH DYSTROPHY UNSPEC	'33720'	1
REFLEX SYMPATH DYSTROPHY UP LIMB	'33721'	1
REFLEX SYMPATH DYSTROPHY LO LIMB	'33722'	1
AUTONOMIC DYSREFLEXIA (Begin 1998)	'3373 '	1
AUTONOMIC NERVE DIS NEC	'3379 '	1
NEUROGENIC BLADDER	'34461'	1
CEREBRAL CYSTS	'3480 '	1
ANOXIC BRAIN DAMAGE	'3481 '	1
PSEUDOTUMOR CEREBRI	'3482 '	1
ENCEPHALOPATHY- UNSPECIFIED	'34830'	1
METABOLIC ENCEPHALOPATHY	'34831'	1
OTHER ENCEPHALOPATHY (Begin 2003)	'34839'	1
COMPRESSION OF BRAIN	'3484 '	1
CEREBRAL EDEMA	'3485 '	1
BRAIN CONDITIONS NEC (end 2009)	'3488 '	1
BRAIN CONDITION NOS	'3489 '	1
BRACHIAL PLEXUS LESIONS	'3530 '	1
NEURALGIC AMYOTROPHY	'3535 '	1
PHANTOM LIMB (SYNDROME)	'3536 '	1
NEUROPATHY IN DIABETES	'3572 '	1
NEUROPATHY IN OTHER DIS	'3574 '	1
ALCOHOL POLYNEUROPATHY	'3575 '	1
CHRONIC INFLAMM DEMYELINATING PLYNEUR (Begin 2002)	'35781'	1

Sensorineural hearing loss, unspecified	'38910'	1	
Disturbance of skin sensation	'7820'	1	
LUMBOSACRAL PLEX LESION	'3531 '		1
CERVICAL ROOT LESION NEC	'3532 '		1
LUMBSACRAL ROOT LES NEC	'3534 '		1
SPINAL ENTHESOPATHY	'7201 '		1
SACROILIITIS NEC	'7202 '		1
SPONDYLOPATHY IN OTH DIS	'72081'		1
INFLAM SPONDYLOPATHY NEC	'72089'		1
INFLAM SPONDYLOPATHY NOS	'7209 '		1
CERVICAL SPONDYLOSIS	'7210 '		1
CERV SPONDYL W MYELOPATH	'7211 '		1
THORACIC SPONDYLOSIS	'7212 '		1
LUMBOSACRAL SPONDYLOSIS	'7213 '		1
SPOND COMPR THOR SP CORD	'72141'		1
SPOND COMPR LUMB SP CORD	'72142'		1
KISSING SPINE	'7215 '		1
ANKYL VERT HYPEROSTOSIS	'7216 '		1
SPINAL DISORDERS NEC	'7218 '		1
SPONDYLOS NOS W/O MYELOP	'72190'		1
SPONDYLOSIS NOS W MYELOP	'72191'		1
CERVICAL DISC DISPLACMNT	'7220 '		1
LUMBAR DISC DISPLACEMENT	'72210'		1
THORACIC DISC DISPLACMNT	'72211'		1
DISC DISPLACEMENT NOS	'7222 '		1
SCHMORL-s NODES NOS	'72230'		1
SCHMORLS NODE-THORACIC	'72231'		1
SCHMORLS NODE-LUMBAR	'72232'		1
SCHMORLS NODE-REGION NEC	'72239'		1
CERVICAL DISC DEGEN	'7224 '		1
THORACIC DISC DEGEN	'72251'		1
LUMB/LUMBOSAC DISC DEGEN	'72252'		1
DISC DEGENERATION NOS	'7226 '		1
DISC DIS W MYELOPATH NOS	'72270'		1
CERV DISC DIS W MYELOPAT	'72271'		1
THOR DISC DIS W MYELOPAT	'72272'		1
LUMB DISC DIS W MYELOPAT	'72273'		1
POSTLAMINECTOMY SYND NOS	'72280'		1
POSTLAMINECT SYND-CERV	'72281'		1
POSTLAMINECT SYND-THORAC	'72282'		1
POSTLAMINECT SYND-LUMBAR	'72283'		1
DISC DIS NEC/NOS-UNSPEC	'72290'		1
DISC DIS NEC/NOS-CERV	'72291'		1
DISC DIS NEC/NOS-THORAC	'72292'		1
DISC DIS NEC/NOS-LUMBAR	'72293'		1
ADOLES POSTURAL KYPHOSIS	'7370 '		1
KYPHOSIS NOS	'73710'		1
POSTLAMINECTOMY KYPHOSIS	'73712'		1
LORDOSIS NOS	'73720'		1
LORDOSIS NEC	'73729'		1

IDIOPATHIC SCOLIOSIS	'73730'	1	
RESOLV IDIOPATH SCOLIOS	'73731'	1	
PROGR IDIOPATH SCOLIOSIS	'73732'	1	
THORACOGENIC SCOLIOSIS	'73734'	1	
SCOLIOSIS NEC	'73739'	1	
SCOLIOSIS IN OTH DIS	'73743'	1	
CURVATURE OF SPINE NEC	'7378 '	1	
CURVATURE OF SPINE NOS	'7379 '	1	
C1-C4 SPIN CORD INJ NOS	'95200'	1	
CENTRAL CORD SYND/C1-C4	'95203'	1	
C1-C4 SPIN CORD INJ NEC	'95204'	1	
C5-C7 SPIN CORD INJ NOS	'95205'	1	
CENTRAL CORD SYND/C5-C7	'95208'	1	
T1-T6 SPIN CORD INJ NOS	'95210'	1	
T1-T6 SPIN CORD INJ NEC	'95214'	1	
T7-T12 SPIN CORD INJ NOS	'95215'	1	
LUMBAR SPINAL CORD INJUR	'9522 '	1	
SPINAL CORD INJURY NOS	'9529 '	1	
Lumbago	'7242'	1	
Backache, unspecified	'7245'	1	
Cervicalgia	'7231'	1	
GENERAL OSTEOARTHROSIS	'71500'		1
GEN OSTEOARTHROS-HAND	'71504'		1
GENERAL OSTEOARTHROSIS	'71509'		1
LOC PRIM OSTEOART-UNSPEC	'71510'		1
LOC PRIM OSTEOART-SHLDER	'71511'		1
LOC PRIM OSTEOART-FORARM	'71513'		1
LOC PRIM OSTEOARTH-HAND	'71514'		1
LOC PRIM OSTEOART-PELVIS	'71515'		1
LOC PRIM OSTEOART-L/LEG	'71516'		1
LOC PRIM OSTEOARTH-ANKLE	'71517'		1
LOC PRIM OSTEOARTHR NEC	'71518'		1
LOC 2ND OSTEOARTH-SHLDER	'71521'		1
LOC 2ND OSTEOART-FOREARM	'71523'		1
LOC 2ND OSTEOARTH-PELVIS	'71525'		1
LOC 2ND OSTEOARTHR-L/LEG	'71526'		1
LOC 2ND OSTEOARTHR-ANKLE	'71527'		1
LOC OSTEOARTH NOS-UNSPEC	'71530'		1
LOC OSTEOARTH NOS-SHLDER	'71531'		1
LOC OSTEOARTH NOS-UP/ARM	'71532'		1
LOC OSTEOART NOS-FOREARM	'71533'		1
LOC OSTEOARTH NOS-HAND	'71534'		1
LOC OSTEOARTH NOS-PELVIS	'71535'		1
LOC OSTEOARTH NOS-L/LEG	'71536'		1
LOC OSTEOARTH NOS-ANKLE	'71537'		1
LOC OSTEOAR NOS-SITE NEC	'71538'		1
OSTEOARTHROSIS-MULT SITE	'71580'		1
OSTEOARTHROSIS-MULT SITE	'71589'		1
OSTEOARTHROS NOS-UNSPEC	'71590'		1
OSTEOARTHROS NOS-SHLDER	'71591'		1

OSTEOARTHROS NOS-UP/ARM	'71592'	1
OSTEOARTHROS NOS-FOREARM	'71593'	1
OSTEOARTHROS NOS-HAND	'71594'	1
OSTEOARTHROS NOS-PELVIS	'71595'	1
OSTEOARTHROS NOS-L/LEG	'71596'	1
OSTEOARTHROS NOS-ANKLE	'71597'	1
OSTEOARTHRO NOS-OTH SITE	'71598'	1
KASCHIN-BECK DIS-L/LEG	'71606'	1
KASCHIN-BECK DIS-MULT	'71609'	1
TRAUM ARTHROPATHY-UNSPEC	'71610'	1
TRAUM ARTHROPATHY-SHLDER	'71611'	1
TRAUM ARTHROPATHY-UP/ARM	'71612'	1
TRAUM ARTHROPATH-FOREARM	'71613'	1
TRAUM ARTHROPATHY-HAND	'71614'	1
TRAUM ARTHROPATHY-PELVIS	'71615'	1
TRAUM ARTHROPATHY-L/LEG	'71616'	1
TRAUM ARTHROPATHY-ANKLE	'71617'	1
CLIMACT ARTHRITIS-PELVIS	'71635'	1
CLIMACT ARTHRITIS-L/LEG	'71636'	1
TRANS ARTHROPATHY-UNSPEC	'71640'	1
TRANS ARTHROPATHY-HAND	'71644'	1
TRANS ARTHROPATHY-PELVIS	'71645'	1
TRANS ARTHROPATHY-L/LEG	'71646'	1
POLYARTHRITIS NOS-UNSPEC	'71650'	1
POLYARTHRIT NOS-FOREARM	'71653'	1
POLYARTHRITIS NOS-HAND	'71654'	1
POLYARTHRITIS NOS-L/LEG	'71656'	1
POLYARTHRITIS NOS-MULT	'71659'	1
MONOARTHRITIS NOS-UNSPEC	'71660'	1
MONOARTHRITIS NOS-SHLDER	'71661'	1
MONOARTHRIT NOS-FOREARM	'71663'	1
MONOARTHRITIS NOS-HAND	'71664'	1
MONOARTHRITIS NOS-PELVIS	'71665'	1
MONOARTHRITIS NOS-L/LEG	'71666'	1
MONOARTHRITIS NOS-ANKLE	'71667'	1
MONOARTHRIT NOS-OTH SITE	'71668'	1
ARTHROPATHY NEC-UNSPEC	'71680'	1
ARTHROPATHY NEC-SHLDER	'71681'	1
ARTHROPATHY NEC-PELVIS	'71685'	1
ARTHROPATHY NEC-L/LEG	'71686'	1
ARTHROPATHY NEC-OTH SITE	'71688'	1
ARTHROPATHY NEC-MULT	'71689'	1
ARTHROPATHY NOS-UNSPEC	'71690'	1
ARTHROPATHY NOS-SHLDER	'71691'	1
ARTHROPATHY NOS-UP/ARM	'71692'	1
ARTHROPATHY NOS-FOREARM	'71693'	1
ARTHROPATHY NOS-HAND	'71694'	1
ARTHROPATHY NOS-PELVIS	'71695'	1
ARTHROPATHY NOS-L/LEG	'71696'	1
ARTHROPATHY NOS-ANKLE	'71697'	1

ARTHROPATHY NOS-OTH SITE	'71698'	1	
ARTHROPATHY NOS-MULT	'71699'	1	
GOUTY ARTHROPATHY (end 2009)	'2740 '		1
URIC ACID NEPHROLITHIAS	'27411'		1
GOUTY TOPHI OF EAR	'27481'		1
GOUTY TOPHI SITE NEC	'27482'		1
GOUT NOS	'2749 '		1
DICALC PHOS CRYST-UNSPEC	'71210'		1
DICALC PHOS CRYST-MULT	'71219'		1
PYROPHOSPH CRYST-UNSPEC	'71220'		1
PYROPHOSPH CRYST-FOREARM	'71223'		1
PYROPHOSPH CRYST-L/LEG	'71226'		1
CHONDROCALCIN NOS-UNSPEC	'71230'		1
CHONDROCALCIN NOS-SHLDER	'71231'		1
CHONDROCALC NOS-FOREARM	'71233'		1
CHONDROCALCIN NOS-HAND	'71234'		1
CHONDROCALCIN NOS-PELVIS	'71235'		1
CHONDROCALCIN NOS-L/LEG	'71236'		1
CHONDROCALCIN NOS-ANKLE	'71237'		1
CHONDROCALC NOS-OTH SITE	'71238'		1
CHONDROCALCIN NOS-MULT	'71239'		1
CRYS ARTHROP NEC-FOREARM	'71283'		1
CRYST ARTHROP NEC-L/LEG	'71286'		1
CRY ARTHROP NEC-OTH SITE	'71288'		1
CRYST ARTHROP NOS-UNSPEC	'71290'		1
CRYS ARTHROP NOS-FOREARM	'71293'		1
CRYST ARTHROP NOS-HAND	'71294'		1
CRYST ARTHROP NOS-L/LEG	'71296'		1
CRYST ARTHROP NOS-ANKLE	'71297'		1

ICD-9 DIAGNOSIS CODE DESCRIPTION	ICD-9 DIAGNOSIS CODE	**Hematologic and Oncologic Conditions**	Anemia	Sickle cell anemia	Malignant neoplasm	**Allergy and Immunity Conditions**	Allergic rhinitis	Immunity disorder	Lupus	Rheumatoid arthritis	Tuberculosis	Human immunodeficiency virus	**Mental Health Conditions**	Anxiety disorders	Depression and depressive disorders	Bipolar disorder	Substance-use Disorders	Personality disorder	Schizophrenia and Psychotic Disorders	Sleep Disorders	Behavior disorders	**Endocrine Conditions**	Thyroid disorder
DIS IRON METABOLISM	'2750 '	1																					
HEREDITARY SPHEROCYTOSIS	'2820 '	1																					
HEREDIT ELLIPTOCYTOSIS	'2821 '	1																					
GLUTATHIONE DIS ANEMIA	'2822 '	1																					
THALASSEMIAS (End 2003)	'2824 '	1																					
OTHER THALASSEMIA	'28249'	1																					
HEMOGLOBINOPAT NEC	'2827 '	1																					
HERED HEMOLYTIC ANEM NOS	'2829 '	1																					
AUTOIMMUN HEMOLYTIC ANEM	'2830 '	1																					
HEMOLYTIC-UREMIC SYNDROME (Begin 1993)	'28311'	1																					
OTH HEMOLYTIC ANEMIAS	'28319'	1																					
HEMOLYTIC HEMOGLOBINURIA	'2832 '	1																					
ACQ HEMOLYT ANEM NOS	'2839 '	1																					
CONSTITUTION RBC APLASIA (Begin 2006)	'28401'	1																					
PANCYTOPENIA	'2841 '	1																					
MYELOPHTHISIS	'2842 '	1																					
APLASTIC ANEMIAS NEC	'2848 '	1																					
APLASTIC ANEMIAS NEC	'28489'	1																					
APLASTIC ANEMIA NOS	'2849 '	1																					
Anemia, unspecified	'2859'	1																					
Iron deficiency anemia,	'2809'	1																					

unspecified			
SICKLE-CELL THALASSEMIA WITHOUT CRISIS (Begin 2003)	'28241'	1	
SICKLE-CELL TRAIT	'2825 '	1	
SICKLE-CELL ANEMIA NOS	'28260'	1	
HB-S DISEASE W/O CRISIS	'28261'	1	
HB-S DISEASE WITH CRISIS	'28262'	1	
MAL NEO UPPER VERMILION	'1400 '		1
MAL NEO LIP NEC	'1408 '		1
MAL NEO LIP/VERMIL NOS	'1409 '		1
MAL NEO TONGUE BASE	'1410 '		1
MAL NEO TIP/LAT TONGUE	'1412 '		1
MALIG NEO TONGUE NOS	'1419 '		1
MALIG NEO PAROTID	'1420 '		1
MAL NEO SALIVARY NOS	'1429 '		1
MALIG NEO LOWER GUM	'1431 '		1
MALIG NEO GUM NOS	'1439 '		1
MAL NEO LAT FLR MOUTH	'1441 '		1
MAL NEO MOUTH FLR NEC	'1448 '		1
MAL NEO MOUTH FLR NOS	'1449 '		1
MAL NEO CHEEK MUCOSA	'1450 '		1
MAL NEO MOUTH VESTIBULE	'1451 '		1
MALIG NEO HARD PALATE	'1452 '		1
MALIG NEO SOFT PALATE	'1453 '		1
MALIGNANT NEO PALATE NOS	'1455 '		1
MALIG NEO RETROMOLAR	'1456 '		1
MALIG NEOPLASM MOUTH NOS	'1459 '		1
MALIGNANT NEOPL TONSIL	'1460 '		1
MAL NEO TONSILLAR FOSSA	'1461 '		1
MAL NEO POST OROPHARYNX	'1467 '		1
MALIG NEO OROPHARYNX NOS	'1469 '		1
MAL NEO POST NASOPHARYNX	'1471 '		1
MAL NEO NASOPHARYNX NOS	'1479 '		1
MAL NEO POSTCRICOID	'1480 '		1
MAL NEO PYRIFORM SINUS	'1481 '		1
MAL NEO HYPOPHARYNX NOS	'1489 '		1

MAL NEO PHARYNX NOS	'1490 '	1
MAL NEO UPPER 3RD ESOPH	'1503 '	1
MAL NEO LOWER 3RD ESOPH	'1505 '	1
MAL NEO ESOPHAGUS NEC	'1508 '	1
MAL NEO ESOPHAGUS NOS	'1509 '	1
MAL NEO STOMACH CARDIA	'1510 '	1
MALIGNANT NEO PYLORUS	'1511 '	1
MAL NEO PYLORIC ANTRUM	'1512 '	1
MAL NEO STOMACH FUNDUS	'1513 '	1
MAL NEO STOMACH BODY	'1514 '	1
MAL NEO STOM GREAT CURV	'1516 '	1
MALIG NEOPL STOMACH NEC	'1518 '	1
MALIG NEOPL STOMACH NOS	'1519 '	1
MALIGNANT NEOPL DUODENUM	'1520 '	1
MALIGNANT NEOPL JEJUNUM	'1521 '	1
MALIGNANT NEOPLASM ILEUM	'1522 '	1
MAL NEO SMALL BOWEL NEC	'1528 '	1
MAL NEO SMALL BOWEL NOS	'1529 '	1
MAL NEO HEPATIC FLEXURE	'1530 '	1
MAL NEO TRANSVERSE COLON	'1531 '	1
MAL NEO DESCEND COLON	'1532 '	1
MAL NEO SIGMOID COLON	'1533 '	1
MALIGNANT NEOPLASM CECUM	'1534 '	1
MALIGNANT NEO APPENDIX	'1535 '	1
MALIG NEO ASCEND COLON	'1536 '	1
MAL NEO SPLENIC FLEXURE	'1537 '	1
MALIGNANT NEO COLON NEC	'1538 '	1

MALIGNANT NEO COLON NOS	'1539 '	1	
MAL NEO RECTOSIGMOID JCT	'1540 '	1	
MALIGNANT NEOPL RECTUM	'1541 '	1	
MALIG NEOPL ANAL CANAL	'1542 '	1	
MALIGNANT NEO ANUS NOS	'1543 '	1	
MAL NEO RECTUM/ANUS NEC	'1548 '	1	
MAL NEO LIVER- PRIMARY	'1550 '	1	
MAL NEO INTRAHEPAT DUCTS	'1551 '	1	
MALIGNANT NEO LIVER NOS	'1552 '	1	
MALIG NEO GALLBLADDER	'1560 '	1	
MAL NEO EXTRAHEPAT DUCTS	'1561 '	1	
MAL NEO AMPULLA OF VATER	'1562 '	1	
MAL NEO PANCREAS HEAD	'1570 '	1	
MAL NEO PANCREAS BODY	'1571 '	1	
MAL NEO PANCREAS TAIL	'1572 '	1	
MAL NEO PANCREATIC DUCT	'1573 '	1	
MAL NEO ISLET LANGERHANS	'1574 '	1	
MALIG NEO PANCREAS NEC	'1578 '	1	
MALIG NEO PANCREAS NOS	'1579 '	1	
MAL NEO RETROPERITONEUM	'1580 '	1	
MAL NEO PERITONEUM NEC	'1588 '	1	
MAL NEO PERITONEUM NOS	'1589 '	1	
MALIG NEO INTESTINE NOS	'1590 '	1	
MAL NEO GI/INTRA-ABD NEC	'1598 '	1	
MAL NEO GI TRACT ILL-DEF	'1599 '	1	
MAL NEO NASAL CAVITIES	'1600 '	1	
MAL NEO MAXILLARY SINUS	'1602 '	1	
MALIG NEO FRONTAL SINUS	'1604 '	1	

MAL NEO ACCESS SINUS NOS	'1609 '	1
MALIGNANT NEO GLOTTIS	'1610 '	1
MALIG NEO SUPRAGLOTTIS	'1611 '	1
MALIGNANT NEO LARYNX NEC	'1618 '	1
MALIGNANT NEO LARYNX NOS	'1619 '	1
MALIGNANT NEO TRACHEA	'1620 '	1
MALIG NEO MAIN BRONCHUS	'1622 '	1
MAL NEO UPPER LOBE LUNG	'1623 '	1
MAL NEO MIDDLE LOBE LUNG	'1624 '	1
MAL NEO LOWER LOBE LUNG	'1625 '	1
MAL NEO BRONCH/LUNG NEC	'1628 '	1
MAL NEO BRONCH/LUNG NOS	'1629 '	1
MALIG NEOPL PLEURA NEC	'1638 '	1
MALIG NEOPL PLEURA NOS	'1639 '	1
MAL NEO ANT MEDIASTINUM	'1642 '	1
MAL NEO MEDIASTINUM NOS	'1649 '	1
MAL NEO RESP SYSTEM NOS	'1659 '	1
MAL NEO SKULL/FACE BONE	'1700 '	1
MALIGNANT NEO MANDIBLE	'1701 '	1
MALIG NEO VERTEBRAE	'1702 '	1
MAL NEO RIBS/STERN/CLAV	'1703 '	1
MAL NEO LONG BONES ARM	'1704 '	1
MAL NEO BONES WRIST/HAND	'1705 '	1
MAL NEO PELVIC GIRDLE	'1706 '	1
MAL NEO LONG BONES LEG	'1707 '	1
MAL NEO BONES ANKLE/FOOT	'1708 '	1
MALIG NEOPL BONE NOS	'1709 '	1
MAL NEO SOFT TISSUE	'1710 '	1

HEAD		
MAL NEO SOFT TISSUE ARM	'1712 '	1
MAL NEO SOFT TISSUE LEG	'1713 '	1
MAL NEO SOFT TIS THORAX	'1714 '	1
MAL NEO SOFT TIS ABDOMEN	'1715 '	1
MAL NEO SOFT TIS PELVIS	'1716 '	1
MAL NEOPL TRUNK NOS	'1717 '	1
MAL NEO SOFT TISSUE NEC	'1718 '	1
MAL NEO SOFT TISSUE NOS	'1719 '	1
MALIG MELANOMA EAR	'1722 '	1
MAL MELANOM FACE NEC/NOS	'1723 '	1
MAL MELANOMA SCALP/NECK	'1724 '	1
MALIG MELANOMA TRUNK	'1725 '	1
MALIG MELANOMA ARM	'1726 '	1
MALIG MELANOMA LEG	'1727 '	1
MALIG MELANOMA SKIN NEC	'1728 '	1
MALIG MELANOMA SKIN NOS	'1729 '	1
MALIG NEO SKIN LIP	'1730 '	1
MAL NEO SKIN FACE NEC	'1733 '	1
MAL NEO SCALP/SKIN NECK	'1734 '	1
MALIG NEO SKIN TRUNK	'1735 '	1
MALIG NEO SKIN NOS	'1739 '	1
MALIG NEO NIPPLE	'1740 '	1
MAL NEO BREAST-CENTRAL	'1741 '	1
MAL NEO BREAST UP-INNER	'1742 '	1
MAL NEO BREAST LOW-INNER	'1743 '	1
MAL NEO BREAST UP-OUTER	'1744 '	1
MAL NEO BREAST LOW-OUTER	'1745 '	1
MAL NEO BREAST-AXILLARY	'1746 '	1
MALIGN NEOPL BREAST	'1748 '	1

NEC		
MALIGN NEOPL BREAST NOS	'1749 '	1
MAL NEO MALE NIPPLE	'1750 '	1
MAL NEO MALE BREAST NEC	'1759 '	1
KAPOSI-S SARCOMA NOS (Begin 1991)	'1769 '	1
MALIG NEOPL UTERUS NOS	'179 '	1
MALIGNANT NEOPL PLACENTA	'181 '	1
MALIG NEO CORPUS UTERI	'1820 '	1
MAL NEO UTERINE ISTHMUS	'1821 '	1
MAL NEO BODY UTERUS NEC	'1828 '	1
MALIGN NEOPL OVARY	'1830 '	1
MAL NEO FALLOPIAN TUBE	'1832 '	1
MAL NEO ADNEXA NOS	'1839 '	1
MALIGN NEOPL VAGINA	'1840 '	1
MALIGN NEOPL VULVA NOS	'1844 '	1
MAL NEO FEMALE GENIT NOS	'1849 '	1
MALIGN NEOPL PROSTATE	'185 '	1
MALIG NEO TESTIS NEC	'1869 '	1
MALIG NEO PENIS NOS	'1874 '	1
MALIGN NEOPL SCROTUM	'1877 '	1
MAL NEO MALE GENITAL NOS	'1879 '	1
MAL NEO BLADDER-TRIGONE	'1880 '	1
MAL NEO BLADDER-DOME	'1881 '	1
MAL NEO BLADDER-LATERAL	'1882 '	1
MAL NEO BLADDER-ANTERIOR	'1883 '	1
MAL NEO BLADDER-POST	'1884 '	1
MAL NEO BLADDER NECK	'1885 '	1
MAL NEO URETERIC ORIFICE	'1886 '	1
MALIG NEO BLADDER NEC	'1888 '	1
MALIG NEO BLADDER NOS	'1889 '	1
MALIG NEOPL KIDNEY	'1890 '	1
MALIG NEO RENAL PELVIS	'1891 '	1
MALIGN NEOPL URETER	'1892 '	1
MALIGN NEOPL URETHRA	'1893 '	1

MAL NEO URINARY NEC	'1898 '	1	
MAL NEO URINARY NOS	'1899 '	1	
MALIGN NEOPL ORBIT	'1901 '	1	
MAL NEO CONJUNCTIVA	'1903 '	1	
MALIGN NEOPL RETINA	'1905 '	1	
MALIGN NEOPL CHOROID	'1906 '	1	
MALIGN NEOPL EYE NOS	'1909 '	1	
MALIGN NEOPL CEREBRUM	'1910 '	1	
MALIG NEO FRONTAL LOBE	'1911 '	1	
MAL NEO TEMPORAL LOBE	'1912 '	1	
MAL NEO PARIETAL LOBE	'1913 '	1	
MAL NEO OCCIPITAL LOBE	'1914 '	1	
MAL NEO CEREB VENTRICLE	'1915 '	1	
MAL NEO CEREBELLUM NOS	'1916 '	1	
MAL NEO BRAIN STEM	'1917 '	1	
MALIG NEO BRAIN NEC	'1918 '	1	
MALIG NEO BRAIN NOS	'1919 '	1	
MAL NEO CRANIAL NERVES	'1920 '	1	
MAL NEO CEREBRAL MENING	'1921 '	1	
MAL NEO SPINAL CORD	'1922 '	1	
MALIGN NEOPL THYROID	'193 '	1	
MALIGN NEOPL ADRENAL	'1940 '	1	
MALIGN NEO PINEAL GLAND	'1944 '	1	
MAL NEO HEAD/FACE/NECK	'1950 '	1	
MALIGN NEOPL THORAX	'1951 '	1	
MALIG NEO ABDOMEN	'1952 '	1	
MALIGN NEOPL PELVIS	'1953 '	1	
MALIGN NEOPL ARM	'1954 '	1	
MALIGN NEOPL LEG	'1955 '	1	
MALIG NEO SITE NEC	'1958 '	1	
MAL NEO LYMPH-HEAD/NECK	'1960 '	1	
MAL NEO LYMPH-INTRATHOR	'1961 '	1	
MAL NEO LYMPH INTRA-ABD	'1962 '	1	
MAL NEO LYMPH-AXILLA/ARM	'1963 '	1	
MAL NEO LYMPH-INGUIN/LEG	'1965 '	1	
MAL NEO LYMPH-INTRAPELV	'1966 '	1	

MAL NEO LYMPH NODE-MULT	'1968 '	1
MAL NEO LYMPH NODE NOS	'1969 '	1
SECONDARY MALIG NEO LUNG	'1970 '	1
SEC MAL NEO MEDIASTINUM	'1971 '	1
SECOND MALIG NEO PLEURA	'1972 '	1
SEC MALIG NEO RESP NEC	'1973 '	1
SEC MALIG NEO SM BOWEL	'1974 '	1
SEC MALIG NEO LG BOWEL	'1975 '	1
SEC MAL NEO PERITONEUM	'1976 '	1
SECOND MALIG NEO LIVER	'1977 '	1
SEC MAL NEO GI NEC	'1978 '	1
SECOND MALIG NEO KIDNEY	'1980 '	1
SEC MALIG NEO URIN NEC	'1981 '	1
SECONDARY MALIG NEO SKIN	'1982 '	1
SEC MAL NEO BRAIN/SPINE	'1983 '	1
SEC MALIG NEO NERVE NEC	'1984 '	1
SECONDARY MALIG NEO BONE	'1985 '	1
SECOND MALIG NEO OVARY	'1986 '	1
SECOND MALIG NEO ADRENAL	'1987 '	1
SECOND MALIG NEO BREAST	'19881'	1
SECOND MALIG NEO GENITAL	'19882'	1
SECONDARY MALIG NEO NEC	'19889'	1
MALIG NEO DISSEMINATED	'1990 '	1
MALIGNANT NEOPLASM NOS	'1991 '	1
RETICULOSARCOMA UNSPEC	'20000'	1
RETICULOSARCOMA HEAD	'20001'	1
RETICULOSARCOMA THORAX	'20002'	1
RETICULOSARCOMA ABDOM	'20003'	1

RETICULOSARCOMA AXILLA	'20004'	1	
RETICULOSARCOMA INGUIN	'20005'	1	
RETICULOSARCOMA PELVIC	'20006'	1	
RETICULOSARCOMA MULT	'20008'	1	
LYMPHOSARCOMA UNSPEC	'20010'	1	
LYMPHOSARCOMA HEAD	'20011'	1	
LYMPHOSARCOMA INGUIN	'20015'	1	
LYMPHOSARCOMA MULT	'20018'	1	
BURKITT-s TUMOR UNSPEC	'20020'	1	
BURKITT-s TUMOR ABDOM	'20023'	1	
MARGIN ZONE LYM HEAD (Begin 2007)	'20031'	1	
MANTLE CELL LYM XTRRNDL (Begin 2007)	'20040'	1	
LARGE CELL LYMPH XTRNDL (Begin 2007)	'20070'	1	
LARGE CELL LYMPH MULTIP (Begin 2007)	'20078'	1	
MIXED LYMPHOSARC UNSPEC	'20080'	1	
MIXED LYMPHOSARC ABDOM	'20083'	1	
MIXED LYMPHOSARC INGUIN	'20085'	1	
HODGKINS PARAGRAN UNSPEC	'20100'	1	
HODG NODUL SCLERO UNSPEC	'20150'	1	
HODG NODUL SCLERO HEAD	'20151'	1	
HODG NODUL SCLERO THORAX	'20152'	1	
HODG NODUL SCLERO MULT	'20158'	1	
HODGKINS DIS NOS UNSPEC	'20190'	1	
HODGKINS DIS NOS HEAD	'20191'	1	
HODGKINS DIS NOS ABDOM	'20193'	1	
HODGKINS DIS NOS MULT	'20198'	1	
NODULAR LYMPHOMA UNSPEC	'20200'	1	
NODULAR LYMPHOMA	'20201'	1	

HEAD		
NODULAR LYMPHOMA ABDOM	'20203'	1
NODULAR LYMPHOMA AXILLA	'20204'	1
NODULAR LYMPHOMA INGUIN	'20205'	1
NODULAR LYMPHOMA MULT	'20208'	1
MYCOSIS FUNGOIDES UNSPEC	'20210'	1
MYCOSIS FUNGOIDES HEAD	'20211'	1
MYCOSIS FUNGOIDES THORAX	'20212'	1
MYCOSIS FUNGOIDES ABDOM	'20213'	1
MYCOSIS FUNGOIDES INGUIN	'20215'	1
MYCOSIS FUNGOIDES MULT	'20218'	1
HAIRY-CELL LEUKEM UNSPEC	'20240'	1
LETTERER-SIWE DIS MULT	'20258'	1
MAL MASTOCYTOSIS UNSPEC	'20260'	1
PERIPH T CELL LYM XTRNDL (Begin 2007)	'20270'	1
LYMPHOMA NEC UNSPEC SITE	'20280'	1
LYMPHOMAS NEC HEAD	'20281'	1
LYMPHOMAS NEC THORAX	'20282'	1
LYMPHOMAS NEC ABDOM	'20283'	1
LYMPHOMAS NEC AXILLA	'20284'	1
LYMPHOMAS NEC INGUIN	'20285'	1
LYMPHOMAS NEC PELVIC	'20286'	1
LYMPHOMAS NEC SPLEEN	'20287'	1
LYMPHOMAS NEC MULT	'20288'	1
LYMPHOID MAL NEC UNSPEC	'20290'	1
LYMPHOID MAL NEC HEAD	'20291'	1
LYMPHOID MAL NEC ABDOM	'20293'	1
MULTIPLE MYELOMA	'2030 '	1
MULT MYELM W/O REMISSION (Begin 1991)	'20300'	1
MULT MYELM W	'20301'	1

REMISSION (Begin 1991)		
OTH IMNPRFL NPL W/O RMSN (Begin 1991)	'20380'	1
ACT LYM LEUK W/O RMSION (Begin 1991)	'20400'	1
ACT LYM LEUK W RMSION	'20401'	1
CHR LYM LEUK W/O RMSION (Begin 1991)	'20410'	1
CHR LYM LEUK W RMSION	'20411'	1
OTH LYM LEUK W/O RMSION (Begin 1991)	'20480'	1
UNS LYM LEUK W/O RMSION (Begin 1991)	'20490'	1
UNS LYM LEUK W RMSION	'20491'	1
ACUTE MYELOID LEUKEMIA	'2050 '	1
ACT MYL LEUK W/O RMSION (Begin 1991)	'20500'	1
ACT MYL LEUK W RMSION	'20501'	1
CHR MYL LEUK W/O RMSION (Begin 1991)	'20510'	1
CHR MYL LEUK W RMSION	'20511'	1
OTH MYL LEUK W/O RMSION (Begin 1991)	'20580'	1
UNS MYL LEUK W/O RMSION (Begin 1991)	'20590'	1
SBAC MONO LEUK W/O RMSON (Begin 1991)	'20620'	1
UNS MONO LEUK W/O RMSION (Begin 1991)	'20690'	1
ACT ERTH/ERYLK W/O RMSON (Begin 1991)	'20700'	1
CHR ERYTHRM W/O REMISION (Begin 1991)	'20710'	1
OTH SPF LEUK W/O REMSION (Begin 1991)	'20780'	1
ACT LEUK UNS CL W/O RMSN	'2080 '	1
ACT LEUK UNS CL W/O RMSN (Begin 1991)	'20800'	1
CHR LEUK UNS CL W/O RMSN (Begin 1991)	'20810'	1
CHR LEUK UNS CL W RMSON (Begin 1991)	'20811'	1
LEUKEMIA NOS W/O REMSION (Begin 1991)	'20890'	1
CA IN SITU ORAL CAV/PHAR	'2300 '	1

CA IN SITU STOMACH	'2302 '	1
CA IN SITU RECTUM	'2304 '	1
CA IN SITU ANUS NOS	'2306 '	1
CA IN SITU GI NEC/NOS	'2309 '	1
CA IN SITU LARYNX	'2310 '	1
CA IN SITU BRONCHUS/LUNG	'2312 '	1
CA IN SITU RESP SYS NEC	'2318 '	1
CA IN SITU SKIN LIP	'2320 '	1
CA IN SITU EYELID	'2321 '	1
CA IN SITU SKIN EAR	'2322 '	1
CA IN SITU SKIN FACE NEC	'2323 '	1
CA IN SITU SCALP	'2324 '	1
CA IN SITU SKIN TRUNK	'2325 '	1
CA IN SITU SKIN ARM	'2326 '	1
CA IN SITU SKIN LEG	'2327 '	1
CA IN SITU SKIN NEC	'2328 '	1
CA IN SITU SKIN NOS	'2329 '	1
CA IN SITU BREAST	'2330 '	1
CA IN SITU CERVIX UTERI	'2331 '	1
CA IN SITU FEM GEN NEC (end 2007)	'2333 '	1
CA IN SITU PROSTATE	'2334 '	1
CA IN SITU PENIS	'2335 '	1
CA IN SITU BLADDER	'2337 '	1
CA IN SITU URINARY NEC	'2339 '	1
CA IN SITU EYE	'2340 '	1
CA IN SITU NEC	'2348 '	1
CA IN SITU NOS	'2349 '	1
POLYCYTHEMIA VERA	'2384 '	1
PLASMACYTOMA NOS	'2386 '	1
LYMPHOPROLIF DIS NOS	'2387 '	1
ESSNTIAL THROMBOCYTHEMIA	'23871'	1
MYELODYSPLS SYN W 5Q DEL (Begin 2006)	'23874'	1
MYELODYSPLASTIC SYND NOS (Begin 2006)	'23875'	1
MYELOFI W MYELO METAPLAS (Begin 2006)	'23876'	1
LYMPH/HEMATPOITC TIS NEC (Begin 2006)	'23879'	1
CARCINOID SYNDROME	'2592 '	1
HX OF KIDNEY MALIGNANCY	'V1052'	1
HX-LYMPH MALIGN NEC	'V1079'	1

HX-MALIG SKIN MELANOMA	'V1082'	1		
HX-SKIN MALIGNANCY NEC	'V1083'	1		
HX-MALIGN NERVE SYST NEC	'V1086'	1		
CHR MAXILLARY SINUSITIS	'4730 '		1	
CHR FRONTAL SINUSITIS	'4731 '		1	
CHR ETHMOIDAL SINUSITIS	'4732 '		1	
CHR SPHENOIDAL SINUSITIS	'4733 '		1	
CHRONIC SINUSITIS NEC	'4738 '		1	
CHRONIC SINUSITIS NOS-	'4739 '		1	
RHINITIS DUE TO POLLEN	'4770 '		1	
ALLERGIC RHINITIS DUE TO FOOD (Begin 2000)	'4771 '		1	
ALLERG RHINITIS-CAT/DOG (Begin 2004)	'4772 '		1	
ALLERGIC RHINITIS NEC	'4778 '		1	
ALLERGIC RHINITIS NOS	'4779 '		1	
HYPOGAMMAGLOBULINEM NOS	'27900'			1
SELECTIVE IGA IMMUNODEF	'27901'			1
SELECTIVE IGM IMMUNODEF	'27902'			1
SELECTIVE IG DEFIC NEC	'27903'			1
COMMON VARIABL IMMUNODEF	'27906'			1
DIGEORGE-s SYNDROME	'27911'			1
WISKOTT-ALDRICH SYNDROME	'27912'			1
COMBINED IMMUNITY DEFIC	'2792 '			1
IMMUNITY DEFICIENCY NOS	'2793 '			1
AUTOIMMUNE DISEASE NEC (end 2009)	'2794 '			1
IMMUNE MECHANISM DIS NEC	'2798 '			1
IMMUNE MECHANISM DIS NOS	'2799 '			1
AGRANULOCYTOSIS	'2880 '			1
EOSINOPHILIA	'2883 '			1
LYMPHOCYTOSIS-SYMPTOMATC (Begin 2006)	'28861'			1
MONOCYTOSIS-SYMPTOMATIC (Begin 2006)	'28863'			1
PLASMACYTOSIS	'28864'			1

SYST LUPUS ERYTHEMATOSUS	'7100 '		1			
SYSTEMIC SCLEROSIS	'7101 '		1			
SICCA SYNDROME	'7102 '		1			
DERMATOMYOSITIS	'7103 '		1			
POLYMYOSITIS	'7104 '		1			
EOSINOPHILIA MYALGIA	'7105 '		1			
DIFF CONNECT TIS DIS NEC	'7108 '		1			
DIFF CONNECT TIS DIS NOS	'7109 '		1			
RHEUMATOID ARTHRITIS	'7140 '			1		
FELTY-s SYNDROME	'7141 '			1		
SYST RHEUM ARTHRITIS NEC	'7142 '			1		
JUV RHEUM ARTHRITIS NOS	'71430'			1		
POLYART JUV RHEUM ARTHR	'71431'			1		
PAUCIART JUV RHEUM ARTHR	'71432'			1		
MONOART JUV RHEUM ARTHR	'71433'			1		
RHEUMATOID LUNG	'71481'			1		
INFLAMM POLYARTHROP NEC	'71489'			1		
INFLAMM POLYARTHROP NOS	'7149 '			1		
ANKYLOSING SPONDYLITIS	'7200 '			1		
POLYMYALGIA RHEUMATICA	'725 '			1		
PRIM TB COMPLEX-NO EXAM	'01001'				1	
PRIMARY TB NOS-UNSPEC	'01090'				1	
PRIMARY TB NOS-NO EXAM	'01091'				1	
PULMONARY TB NEC-UNSPEC	'01180'				1	
PULMONARY TB NOS-UNSPEC	'01190'				1	
TB BRAIN ABSCESS-UNSPEC	'01330'				1	
TB BRAIN ABSCESS-NO EXAM	'01331'				1	
HIV DISEASE (Begin 1994)	'042 '					1
HIV POSITIVE NOS	'V08 '					1
ANXIETY STATE NOS	'30000'					1
PANIC DISORDER	'30001'					1

GENERALIZED ANXIETY DIS	'30002'		1		
ANXIETY STATE NEC	'30009'		1		
HYSTERIA NOS	'30010'		1		
CONVERSION DISORDER	'30011'		1		
PSYCHOGENIC AMNESIA	'30012'		1		
DISSOCIATIVE REACT NOS	'30015'		1		
PHOBIA NOS	'30020'		1		
AGORAPHOBIA WITH PANIC	'30021'		1		
AGORAPHOBIA WO PANIC	'30022'		1		
SOCIAL PHOBIA	'30023'		1		
ISOLATED PHOBIAS NEC	'30029'		1		
OBSESSIVE-COMP DIS	'3003 '		1		
NEURASTHENIA	'3005 '		1		
DEPERSONALIZATION SYND	'3006 '		1		
HYPOCHONDRIASIS	'3007 '		1		
SOMATIZATION DISORDER	'30081'		1		
SOMATOFORM DIS NOS	'30082'		1		
NEUROTIC DISORDER NOS	'3009 '		1		
ANOREXIA NERVOSA	'3071 '		1		
EATING DISORDER NOS	'30750'		1		
BULIMIA	'30751'		1		
PSYCHOGENIC RUMINATION	'30753'		1		
EATING DISORDER NEC	'30759'		1		
OVERANXIOUS DISORDER	'3130 '		1		
IDENTITY DISORDER	'31382'		1		
CATAPLEXY AND NARCOLEPSY (End 2004)	'347 '		1		
NARCOLEPSY W/O CATAPLEXY (Begin 2004)	'34700'		1		
NARCOLEPSY W CATAPLEXY (Begin 2004)	'34701'		1		
NEUROTIC DEPRESSION	'3004 '			1	
DEPRESSIVE DIS NEC	'311 '			1	
MISERY & UNHAPPINESS DIS	'3131 '			1	
MANIC DISORDER-UNSPEC	'29600'				1
MANIC DIS-FULL REMISSION	'29606'				1
RECUR MANIC DIS-UNSPEC	'29610'				1
RECUR MANIC DIS-MOD	'29612'				1
RECUR MANIC DIS-SEVERE	'29613'				1
RECUR MANIC-SEV W PSYCHO	'29614'				1
RECUR MANIC-PART	'29615'				1

REMISS			
DEPRESS PSYCHOSIS-UNSPEC	'29620'		1
DEPRESS PSYCHOSIS-MILD	'29621'		1
DEPRESSIVE PSYCHOSIS-MOD	'29622'		1
DEPRESS PSYCHOSIS-SEVERE	'29623'		1
DEPR PSYCHOS-SEV W PSYCH	'29624'		1
DEPR PSYCHOS-PART REMISS	'29625'		1
DEPR PSYCHOS-FULL REMISS	'29626'		1
RECURR DEPR PSYCHOS-UNSP	'29630'		1
RECURR DEPR PSYCHOS-MILD	'29631'		1
RECURR DEPR PSYCHOS-MOD	'29632'		1
RECUR DEPR PSYCH-SEVERE	'29633'		1
REC DEPR PSYCH-PSYCHOTIC	'29634'		1
RECUR DEPR PSYC-PART REM	'29635'		1
RECUR DEPR PSYC-FULL REM	'29636'		1
BIPOL AFF/ MANIC-UNSPEC	'29640'		1
BIPOLAR AFF/ MANIC-MILD	'29641'		1
BIPOLAR AFFEC/ MANIC-MOD	'29642'		1
BIPOL AFF/ MANIC-SEVERE	'29643'		1
BIPOL MANIC-SEV W PSYCH	'29644'		1
BIPOL AFF MANIC-PART REM	'29645'		1
BIPOL AFF MANIC-FULL REM	'29646'		1
BIPOLAR AFF/ DEPR-UNSPEC	'29650'		1
BIPOLAR AFFEC/ DEPR-MILD	'29651'		1
BIPOLAR AFFEC/ DEPR-MOD	'29652'		1
BIPOL AFF/ DEPR-SEVERE	'29653'		1

BIPOL DEPR-SEV W PSYCH	'29654'		1	
BIPOL AFF DEPR-PART REM	'29655'		1	
BIPOLAR AFF/ MIXED-MILD	'29661'		1	
BIPOLAR AFFEC/ MIXED-MOD	'29662'		1	
BIPOL AFF/ MIXED-SEVERE	'29663'		1	
BIPOL MIXED-SEV W PSYCH	'29664'		1	
BIPOL AFF/ MIX-PART REM	'29665'		1	
BIPOL AFF/ MIX-FULL REM	'29666'		1	
BIPOLAR AFFECTIVE NOS	'2967 '		1	
MANIC-DEPRESSIVE NOS	'29680'		1	
ATYPICAL DEPRESSIVE DIS	'29682'		1	
MANIC-DEPRESSIVE NEC	'29689'		1	
AFFECTIVE PSYCHOSIS NOS	'29690'		1	
AFFECTIVE PSYCHOSES NEC	'29699'		1	
-CYCLOTHYMIC DISORDER-	'30113'		1	
DELIRIUM TREMENS	'2910 '			1
ALCOHOLIC DEMENTIA NEC	'2912 '			1
ALCOHOLIC JEALOUSY	'2915 '			1
ALCOHOL WITHDRAWAL	'29181'			1
ALCOH INDUCE SLEEP DISOR (Begin 2005)	'29182'			1
OT ALCOHOL PSYCHOSIS (Begin 1996)	'29189'			1
ALCOHOLIC PSYCHOSIS NOS	'2919 '			1
AC ALCOHOL INTOX-UNSPEC	'30300'			1
AC ALCOHOL INTOX-CONTIN	'30301'			1
AC ALCOHOL INTOX-EPISOD	'30302'			1
AC ALCOHOL INTOX-REMISS	'30303'			1
ALCOH DEP NECNOS-UNSPEC	'30390'			1
ALCOH DEP NECNOS-CONTIN	'30391'			1
ALCOH DEP NECNOS-EPISOD	'30392'			1
ALCOH DEP NECNOS-REMISS	'30393'			1

OPIOID DEPENDENCE-UNSPEC	'30400'		1
OPIOID DEPENDENCE-CONTIN	'30401'		1
OPIOID DEPENDENCE-EPISOD	'30402'		1
OPIOID DEPENDENCE-REMISS	'30403'		1
BARBITURAT DEPEND-UNSPEC	'30410'		1
BARBITURAT DEPEND-CONTIN	'30411'		1
BARBITURAT DEPEND-REMISS	'30413'		1
COCAINE DEPEND-UNSPEC	'30420'		1
COCAINE DEPEND-CONTIN	'30421'		1
COCAINE DEPEND-EPISODIC	'30422'		1
COCAINE DEPEND-REMISS	'30423'		1
CANNABIS DEPEND-UNSPEC	'30430'		1
CANNABIS DEPEND-CONTIN	'30431'		1
CANNABIS DEPEND-EPISODIC	'30432'		1
CANNABIS DEPEND-REMISS	'30433'		1
AMPHETAMIN DEPEND-UNSPEC	'30440'		1
AMPHETAMIN DEPEND-CONTIN	'30441'		1
AMPHETAMIN DEPEND-REMISS	'30443'		1
HALLUCINOGEN DEP-UNSPEC	'30450'		1
DRUG DEPEND NEC-UNSPEC	'30460'		1
DRUG DEPEND NEC-IN REM	'30463'		1
OPIOIDOTHER DEP-UNSPEC	'30470'		1
OPIOIDOTHER DEP-CONTIN	'30471'		1
COMB DRUG DEP NEC-UNSPEC	'30480'		1
COMB DRUG DEP NEC-CONTIN	'30481'		1
COMB DRUG DEP NEC-REMISS	'30483'		1

DRUG DEPEND NOS-UNSPEC	'30490'		1	
SUSPECT DAMAGE TO FETUS - ANTEPARTUM	'65553'		1	
ALC AFF FETUS VIA BREAST PLACENTA	'76071'		1	
COCAINE AFFECTS FETUS (Begin 1991)	'76075'		1	
POISONING BY OPIUM	'96500'		1	
POISONING BY OTH NARCOTICS	'96509'		1	
TOXIC EFFECT OF ALCOHOL (BEGIN 2007)	'9800 '		1	
MULTIPLE PERSONALITY	'30014'			1
FACTITIOUS ILL NECNOS	'30019'			1
PARANOID PERSONALITY	'3010 '			1
AFFECTIV PERSONALITY NOS	'30110'			1
CHRONIC HYPOMANIC PERSON	'30111'			1
CHR DEPRESSIVE PERSON	'30112'			1
SCHIZOID PERSONALITY NOS	'30120'			1
SCHIZOTYPAL PERSONALITY	'30122'			1
EXPLOSIVE PERSONALITY	'3013 '			1
COMPULSIVE PERSONALITY	'3014 '			1
HISTRIONIC PERSON NOS	'30150'			1
CHR FACTITIOUS ILLNESS	'30151'			1
DEPENDENT PERSONALITY	'3016 '			1
ANTISOCIAL PERSONALITY	'3017 '			1
NARCISSISTIC PERSONALITY	'30181'			1
AVOIDANT PERSONALITY	'30182'			1
BORDERLINE PERSONALITY	'30183'			1
PASSIVE-AGGRESSIV PERSON	'30184'			1
PERSONALITY DISORDER NEC	'30189'			1
PEDOPHILIA	'3022 '			1
PSYCHOSEX IDENTITY DIS	'3026 '			1
PSYCHOSEXUAL DYSFUNC NOS	'30270'			1
PSYCHOSEXUAL DYSFUNC NEC	'30279'			1

PSYCHOGEN MUSCULSKEL DIS	'3060 '		1		
PSYCHOGENIC RESPIR DIS	'3061 '		1		
PSYCHOGENIC SKIN DISEASE	'3063 '		1		
PSYCHOGENIC GI DISEASE	'3064 '		1		
PSYCHOGENIC DYSMENORRHEA	'30652'		1		
PSYCHOGENIC GU DIS NEC	'30659'		1		
PSYCHOGENIC DISORDER NEC	'3068 '		1		
PSYCHOGENIC DISORDER NOS	'3069 '		1		
PSYCHOGENIC PAIN NOS	'30780'		1		
PSYCHOGENIC PAIN NEC	'30789'		1		
INFANTILE AUTISM-ACTIVE	'29900'			1	1
INFANTILE AUTISM-RESID	'29901'			1	1
SIMPL SCHIZOPHREN-UNSPEC	'29500'			1	
HEBEPHRENIA-UNSPEC	'29510'			1	
CATATONIA-UNSPEC	'29520'			1	
CATATONIA-CHRONIC	'29522'			1	
CATATONIA-CHREXACERB	'29524'			1	
PARANOID SCHIZO-UNSPEC	'29530'			1	
PARANOID SCHIZO-CHRONIC	'29532'			1	
PARAN SCHIZO-SUBCHREXAC	'29533'			1	
PARAN SCHIZO-CHREXACERB	'29534'			1	
AC SCHIZOPHRENIA-UNSPEC	'29540'			1	
LATENT SCHIZOPHREN-UNSP	'29550'			1	
LATENT SCHIZOPHREN-CHR	'29552'			1	
RESID SCHIZOPHREN-UNSP	'29560'			1	
RESIDUAL SCHIZOPHREN-CHR	'29562'			1	
SCHIZOAFFECTIVE-UNSPEC	'29570'			1	
SCHIZOAFF-SUBCHREXACER	'29573'			1	
SCHIZOAFFECT-CHREXACER	'29574'			1	

SCHIZOAFFECTIVE-REMISS	'29575'			1		
SCHIZOPHRENIA NOS-UNSPEC	'29590'			1		
SCHIZOPHRENIA NOS-CHR	'29592'			1		
PARANOIA	'2971 '			1		
PARANOID STATE NOS	'2979 '			1		
REACT DEPRESS PSYCHOSIS	'2980 '			1		
EXCITATIV TYPE PSYCHOSIS	'2981 '			1		
REACTIVE CONFUSION	'2982 '			1		
REACT PSYCHOSIS NECNOS	'2988 '			1		
-PSYCHOSIS NOS-	'2989 '			1		
CHILD PSYCHOS NEC-ACTIVE	'29980'			1		
CHILD PSYCHOS NEC-RESID	'29981'			1		
CHILD PSYCHOS NOS-ACTIVE	'29990'			1		
NONORGANIC SLEEP DIS NOS	'30740'				1	
PERSISTENT INSOMNIA	'30742'				1	
PERSISTENT HYPERSOMNIA	'30744'				1	
DISRUPT SLEEP-WAKE CYCLE	'30745'				1	
SOMNAMBULISMNGHT TERROR	'30746'				1	
SLEEP STAGE DYSFUNC NEC	'30747'				1	
REPETIT SLEEP INTRUSION	'30748'				1	
NONORGANIC SLEEP DIS NEC	'30749'				1	
Obstructive sleep apnea (adult)(pediatric)	'32723'				1	
TIC DISORDER NOS	'30720'					1
TRANSIENT TIC/ CHILDHOOD	'30721'					1
CHRONIC MOTOR TIC DIS	'30722'					1
GILLES TOURETTE DISORDER	'30723'					1
UNSOCIAL AGGRESS-SEVERE	'31203'					1
UNSOCIAL UNAGGR-SEVERE	'31213'					1
SOCIAL CONDUCT DIS-SEV	'31223'					1

INTERMITT EXPLOSIVE DIS	'31234'	1	
-IMPULSE CONTROL DIS NEC-	'31239'	1	
OTHER CONDUCT DISTURB	'3128 '	1	
CONDUCT DISORDER/ CHILD ONSET OCT94--	'31281'	1	
CONDUCT DISORDER/ ADOLESC ONSET OCT94--	'31282'	1	
OTHER CONDUCT DISORDER OCT94--	'31289'	1	
CONDUCT DISTURBANCE NOS	'3129 '	1	
ELECTIVE MUTISM	'31323'	1	
OPPOSITIONAL DISORDER	'31381'	1	
EMOTIONAL DIS CHILD NEC	'31389'	1	
EMOTIONAL DIS CHILD NOS	'3139 '	1	
ATTN DEFIC NONHYPERACT	'31400'	1	
ATTN DEFICIT W HYPERACT	'31401'	1	
HYPERKINET W DEVEL DELAY	'3141 '	1	
HYPERKINETIC CONDUCT DIS	'3142 '	1	
-HYPERKINETIC SYND NOS-	'3149 '	1	
TOX DIF GOITER NO CRISIS	'24200'		1
TOX DIF GOITER W CRISIS	'24201'		1
TOX UNINOD GOIT NO CRIS	'24210'		1
TOX MULTNOD GOIT NO CRIS	'24220'		1
TOX MULTNOD GOIT W CRIS	'24221'		1
TOX NOD GOITER NO CRISIS	'24230'		1
TOX NOD GOITER W CRISIS	'24231'		1
THYROTOX-ECT NOD NO CRIS	'24240'		1
THYROTOX NOS NO CRISIS	'24290'		1
THYROTOX NOS W CRISIS	'24291'		1
CONGENITAL HYPOTHYROIDSM	'243 '		1
POSTSURGICAL HYPOTHYROID	'2440 '		1
POSTABLAT HYPOTHYR NEC	'2441 '		1
IODINE HYPOTHYROIDISM	'2442 '		1
IATROGEN HYPOTHYROID	'2443 '		1

NEC			
ACQ HYPOTHYROID NEC	'2448 '		1
HYPOTHYROIDISM NOS	'2449 '		1
ACUTE THYROIDITIS	'2450 '		1
SUBACUTE THYROIDITIS	'2451 '		1
CHR LYMPHOCYT THYROIDIT	'2452 '		1
IATROGENIC THYROIDITIS	'2454 '		1
CHR THYROIDITIS NEC/NOS	'2458 '		1
THYROIDITIS NOS	'2459 '		1
HYPERPARATHYROIDISM	'2520 '		1
HYPERPARATHYROIDISM NOS	'25200'		1
PRIMARY HYPERPARATHYROID	'25201'		1
SEC HYPRPRTHYRD NONRENAL (Begin 2004)	'25202'		1
HYPERPARATHYROIDISM NEC	'25208'		1
HYPOPARATHYROIDISM	'2521 '		1
PARATHYROID DISORDER NEC	'2528 '		1
PARATHYROID DISORDER NOS	'2529 '		1
ACROMEGALY AND GIGANTISM	'2530 '		1
ANT PITUIT HYPERFUNC NEC	'2531 '		1
PANHYPOPITUITARISM	'2532 '		1
ANTER PITUITARY DIS NEC	'2534 '		1
NEUROHYPOPHYSIS DIS NEC	'2536 '		1
IATROGENIC PITUITARY DIS	'2537 '		1
PITUITARY DISORDER NEC	'2538 '		1
PITUITARY DISORDER NOS	'2539 '		1
CUSHING-s SYNDROME	'2550 '		1

ICD-9 DIAGNOSIS CODE DESCRIPTION	ICD-9 DIAGNOSIS CODE	**Other Conditions**						
		Obesity	Chronic skin ulcer	Degenerative eye problem	Amyloidosis	Sarcoidosis	Cystic fibrosis	Non-cardiac congenital disorder
OBESITY (End 1995)	'2780 '	1						
OBESITY UNSPECIFIED	'27800'	1						
MORBID OBESITY	'27801'	1						
BMI 30.0-30.9 (Begin 2005)	'V8530'	1						
BMI 31.0-31.9 (Begin 2005)	'V8531'	1						
BMI 32.0-32.9 (Begin 2005)	'V8532'	1						
BMI 33.0-33.9 (Begin 2005)	'V8533'	1						
BMI 34.0-34.9 (Begin 2005)	'V8534'	1						
BMI 35.0-35.9 (Begin 2005)	'V8535'	1						
BMI 36.0-36.9 (Begin 2005)	'V8536'	1						
BMI 37.0-37.9 (Begin 2005)	'V8537'	1						
BMI 38.0-38.9 (Begin 2005)	'V8538'	1						
BMI 39.0-39.9 (Begin 2005)	'V8539'	1						
BMI 40 AND OVER	'V854 '	1						
PSORIATIC ARTHROPATHY	'6960 '		1					
OTHER PSORIASIS	'6961 '		1					
PARAPSORIASIS	'6962 '		1					
PITYRIASIS ROSEA	'6963 '		1					
PITYRIASIS RUBRA PILARIS	'6964 '		1					
PITYRIASIS NEC & NOS	'6965 '		1					
DECUBITUS ULCER	'7070 '		1					
DECUBITUS ULCER NOS	'70700'		1					
DECUBITUS ULCER,ELBOW	'70701'		1					
DECUBITUS ULCER,UP BACK	'70702'		1					
DECUBITUS ULCER,LOW BACK (Begin 2004)	'70703'		1					
DECUBITUS ULCER,HIP	'70704'		1					
DECUBITUS ULCER,BUTTOCK	'70705'		1					
DECUBITUS ULCER,HEEL	'70707'		1					

DECUBITUS ULCER, NEC	'70709'	1	
CHRONIC ULCER OF LEG	'7071 '	1	
ULCER OF LOWER LIMB-UNSPEC (Begin 2000)	'70710'	1	
ULCER OF THIGH	'70711'	1	
ULCER OF CALF (Begin 2000)	'70712'	1	
ULCER OF ANKLE	'70713'	1	
ULCER OF HEEL & MIDFOOT	'70714'	1	
ULCER OF OTHER PART OF FOOT (Begin 2000)	'70715'	1	
ULCER OF OTHER PART OF LOWER LIMB (Begin 2000)	'70719'	1	
CHRONIC SKIN ULCER NEC	'7078 '	1	
CHRONIC SKIN ULCER NOS	'7079 '	1	
Actinic keratosis	'7020'	1	
Other acne	'7061'	1	
DIABETIC RETINOPATHY NOS	'36201'		1
PROLIF DIAB RETINOPATHY	'36202'		1
BACKGRND RETINOPATHY NOS	'36210'		1
HYPERTENSIVE RETINOPATHY	'36211'		1
EXUDATIVE RETINOPATHY	'36212'		1
MACULAR DEGENERATION NOS	'36250'		1
NONEXUDAT MACULAR DEGEN	'36251'		1
EXUDATIVE MACULAR DEGEN	'36252'		1
CYSTOID MACULAR DEGEN	'36253'		1
PREGLAUCOMA NOS	'36500'		1
OPN ANGL W BORDERLN FIND	'36501'		1
ANATOMICAL NARROW ANGLE	'36502'		1
STEROID RESPONDERS	'36503'		1
OCULAR HYPERTENSION	'36504'		1
OPEN-ANGLE GLAUCOMA NOS	'36510'		1
PRIM OPEN ANGLE GLAUCOMA	'36511'		1
LOW TENSION GLAUCOMA	'36512'		1
PIGMENTARY GLAUCOMA	'36513'		1
GLAUCOMA OF CHILDHOOD	'36514'		1
RESIDUAL OPN ANG GLAUCMA	'36515'		1
PRIM ANGL-CLOS GLAUC NOS	'36520'		1
INTERMIT ANGL-CLOS	'36521'		1

GLAUC						
ACUTE ANGL-CLOS	'36522'	1				
GLAUCOMA						
CHR ANGLE-CLOS	'36523'	1				
GLAUCOMA						
RESIDUAL ANGL-CLOS	'36524'	1				
GLAUC						
GLAUC STAGE-STER	'36531'	1				
INDUCED						
GLAUC W CHAMB ANGLE	'36541'	1				
ANOM						
GLAUCOMA W IRIS	'36542'	1				
ANOMALY						
GLAUCOMA W SYSTEMIC	'36544'	1				
SYND						
PSEUDOEXFOLIAT	'36552'	1				
GLAUCOMA						
GLAUCOMA W LENS DIS NEC	'36559'	1				
GLAUC W OCULAR DIS NOS	'36560'	1				
GLAUC W PUPILLARY BLOCK	'36561'	1				
GLAUCOMA W OCULAR	'36562'	1				
INFLAM						
GLAUCOMA W VASC DIS	'36563'	1				
GLAUCOMA W TUMOR OR	'36564'	1				
CYST						
GLAUCOMA W OCULAR	'36565'	1				
TRAUMA						
AQUEOUS MISDIRECTION	'36583'	1				
GLAUCOMA NEC	'36589'	1				
GLAUCOMA NOS	'3659 '	1				
Myopia	'3671'	1				
Senile nuclear sclerosis	'36616'	1				
AMYLOIDOSIS	'2773 '		1			
AMYLOIDOSIS NOS	'27730'		1			
AMYLOIDOSIS NEC	'27739'		1			
SARCOIDOSIS	'135 '			1		
CYSTIC FIBROS W/O ILEUS	'27700'				1	
CYSTIC FIBROSIS W ILEUS-	'27701'				1	
CYSTIC FIBROSIS W PULM	'27702'				1	
MANFSTATNS (Begin 2002)						
CYSTIC FIBROSIS W	'27703'				1	
GASTRO MANFSTATNS						
CYSTIC FIBROSIS W OTHER	'27709'				1	
MANFSTATNS (Begin 2002)						
PITUITARY DWARFISM	'2533 '					1
CONG FACTOR VIII DIORD	'2860 '					1
CONG FACTOR IX DISORDER	'2861 '					1
CONG FACTOR XI DISORDER	'2862 '					1
CONG DEF CLOT FACT NEC	'2863 '					1
VON WILLEBRAND-s	'2864 '					1

DISEASE		
GENETIC ANOMALY	'2882 '	1
LEUKOCYT		
CONG HERED MUSC	'3590 '	1
DYSTRPHY		
HERED PROG MUSC	'3591 '	1
DYSTRPHY		
SPIN BIF W HYDROCEPH	'74100'	1
NOS		
SPIN BIF W HYDRCEPH-	'74101'	1
CERV		
SPIN BIF W HYDRCEPH-	'74102'	1
DORS		
SPIN BIF W HYDRCEPH-	'74103'	1
LUMB		
SPINA BIFIDA	'74190'	1
SPINA BIFIDA-CERV	'74191'	1
SPINA BIFIDA-DORSAL	'74192'	1
SPINA BIFIDA-LUMBAR	'74193'	1
ENCEPHALOCELE	'7420 '	1
MICROCEPHALUS	'7421 '	1
REDUCTION DEFORM- BRAIN	'7422 '	1
CONGENITAL	'7423 '	1
HYDROCEPHALUS		
BRAIN ANOMALY NEC	'7424 '	1
DIASTEMATOMYELIA	'74251'	1
HYDROMYELIA	'74253'	1
SPINAL CORD ANOM NEC	'74259'	1
NERV SYSTEM ANOM NOS	'7429 '	1
CLINIC ANOPHTHALMOS	'74300'	1
NOS		
MICROPHTHALMOS NOS	'74310'	1
BUPHTHALMOS NOS	'74320'	1
CONG CATARACT NOS	'74330'	1
CAPSULAR CATARACT	'74331'	1
CORTICAL/ZONULAR	'74332'	1
CATARAC		
NUCLEAR CATARACT	'74333'	1
CONG CORN OPAC AFF VIS	'74342'	1
CONG CORN OPACIT NEC	'74343'	1
ANOM ANTER CHAMB-EYE	'74344'	1
ANOM IRIS & CIL BODY NEC	'74346'	1
ANOM ANTER SEG NEC-EYE	'74349'	1
VITREOUS ANOMALIES	'74351'	1
FUNDUS COLOBOMA	'74352'	1
CONG CHORIORETINAL	'74353'	1
DEGEN		
CONG MACUL CHANGE-EYE	'74355'	1
CONG RETINAL CHANGES	'74356'	1
NEC		

OPTIC DISC ANOMALIES	'74357'	1
CONGENITAL PTOSIS	'74361'	1
CONGENITAL EYELID DEFORM	'74362'	1
SPEC ANOM OF EYELID NEC	'74363'	1
SPEC LACR PASS ANOM	'74365'	1
SPEC ANOMALY OF ORBIT	'74366'	1
ANOM EYELID/LACR/ORB NEC	'74369'	1
EYE ANOMALIES NEC	'7438 '	1
EYE ANOMALY NOS	'7439 '	1
EAR ANOM NOS/IMPAIR HEAR	'74400'	1
EX EAR ANM NEC-IMPR HEAR	'74402'	1
MIDDLE EAR ANOMALY NEC	'74403'	1
ACCESSORY AURICLE	'7441 '	1
MACROTIA	'74422'	1
MICROTIA	'74423'	1
EAR ANOMALIES NEC	'74429'	1
EAR ANOMALY NOS	'7443 '	1
BRANCH CLEFT SINUS/FISTU	'74441'	1
BRANCHIAL CLEFT CYST	'74442'	1
CERVICAL AURICLE	'74443'	1
PREAURICULAR SINUS/FISTU	'74446'	1
PREAURICULAR CYST	'74447'	1
MICROSTOMIA	'74484'	1
CONG FACE/NECK ANOM NEC	'74489'	1
CONG FACE/NECK ANOM NOS	'7449 '	1
CHOANAL ATRESIA	'7480 '	1
NOSE ANOMALY NEC	'7481 '	1
LARYNGOTRACH ANOMALY NEC	'7483 '	1
CONGENITAL CYSTIC LUNG	'7484 '	1
AGENESIS OF LUNG	'7485 '	1
LUNG ANOMALY NOS	'74860'	1
CONGEN BRONCHIECTASIS	'74861'	1
LUNG ANOMALY NEC	'74869'	1
CLEFT PALATE NOS	'74900'	1
UNILAT CLEFT PALATE-COMP	'74901'	1
UNILAT CLEFT PALATE-INC	'74902'	1
BILAT CLEFT PALATE-INC	'74904'	1
CLEFT LIP NOS	'74910'	1
BILAT CLEFT LIP-COMPLETE	'74913'	1
CLEFT PALATE & LIP NOS	'74920'	1
UNIL CLEFT PALAT/LIP-COM	'74921'	1

UNIL CLEFT PALAT/LIP-INC	'74922'	1
BILAT CLFT PALAT/LIP-COM	'74923'	1
BILAT CLFT PALAT/LIP-INC	'74924'	1
TONGUE TIE	'7500 '	1
TONGUE ANOMALY NOS	'75010'	1
CONG MACROGLOSSIA	'75015'	1
TONGUE ANOMALY NEC	'75019'	1
MOUTH ANOMALY NEC	'75026'	1
PHARYNGEAL ANOM NEC	'75029'	1
CONG ESOPH FISTULA/ATRES	'7503 '	1
ESOPHAGEAL ANOM NEC	'7504 '	1
CONG PYLORIC STENOSIS	'7505 '	1
CONG HIATUS HERNIA	'7506 '	1
GASTRIC ANOMALY NEC	'7507 '	1
UPPER GI ANOMALY NOS	'7509 '	1
MECKEL-s DIVERTICULUM	'7510 '	1
ATRESIA SMALL INTESTINE	'7511 '	1
INTESTINAL FIXATION ANOM	'7514 '	1
INTESTINAL ANOMALY NEC	'7515 '	1
BILIARY & LIVER ANOM NOS	'75160'	1
CONG CYSTIC LIVER DIS	'75162'	1
BILIARY & LIVER ANOM NEC	'75169'	1
PANCREAS ANOMALIES	'7517 '	1
ANOM DIGESTIVE SYST NEC	'7518 '	1
ANOMALIES OF OVARIES	'7520 '	1
EMBRYONIC CYST OF ADNEXA	'75211'	1
DOUBLING OF UTERUS	'7522 '	1
UTERINE ANOMALY NEC	'7523 '	1
EMBRYON CYST FEM GEN NEC	'75241'	1
IMPERFORATE HYMEN	'75242'	1
CERVIX/FEM GEN ANOM NEC	'75249'	1
UNDESCEND TESTIS	'75251'	1
RETRACTILE TESTIS	'75252'	1
HYPOSPADIAS (Begin 1996)	'75261'	1
EPISPADIAS (Begin 1996)	'75262'	1
CONG CHORDEE	'75263'	1
MICROPENIS (Begin 1996)	'75264'	1
HIDDEN PENIS (Begin 1996)	'75265'	1
OTH PENILE ANOM	'75269'	1
INDETERMINATE SEX	'7527 '	1
SCROTAL TRANSPOSITION	'75281'	1
OTHER SPECIFIED ANOMALIES OF GENITAL ORGANS (Begin 2003)	'75289'	1
GENITAL ORGAN ANOM NOS	'7529 '	1
RENAL AGENESIS	'7530 '	1
CYSTIC KIDNEY DISEAS NOS	'75310'	1

CONGENITAL RENAL CYST	'75311'	1
POLYCYSTIC KIDNEY NOS	'75312'	1
POLYCYST KID-AUTOSOM DOM (Begin 1990)	'75313'	1
RENAL DYSPLASIA	'75315'	1
MEDULLARY SPONGE KIDNEY (Begin 1990)	'75317'	1
CYSTIC KIDNEY DISEAS NEC	'75319'	1
OBSTR URETER NOS	'75320'	1
OBSTR URETERPELV JCT	'75321'	1
OBSTR URETERVESC JCT	'75322'	1
CONG URETEROCELE	'75323'	1
OTH OBSTR DEF URETER	'75329'	1
KIDNEY ANOMALY NEC	'7533 '	1
URETERAL ANOMALY NEC	'7534 '	1
BLADDER EXSTROPHY	'7535 '	1
CONGEN URETHRAL STENOSIS	'7536 '	1
ANOMALIES OF URACHUS	'7537 '	1
CYSTOURETH ANOM NEC	'7538 '	1
URINARY ANOMALY NOS	'7539 '	1
CONG SKULL/FACE/JAW DEF	'7540 '	1
CONGENITAL TORTICOLLIS	'7541 '	1
CONG POSTURAL DEFORMITY	'7542 '	1
CONG HIP DISLOC- UNILAT	'75430'	1
CONGEN HIP DISLOC- BILAT	'75431'	1
CONG HIP SUBLUX- UNILAT	'75432'	1
CONG HIP SUBLUX- BILAT	'75433'	1
CONG KNEE DISLOCATION	'75441'	1
CONG BOWING TIBIA/FIBULA	'75443'	1
CONG BOWING LEG NOS	'75444'	1
TALIPES VARUS	'75450'	1
TALIPES EQUINOVARUS	'75451'	1
METATARSUS PRIMUS VARUS	'75452'	1
METATARSUS VARUS	'75453'	1
CONG VARUS FOOT DEF NEC	'75459'	1
TALIPES VALGUS	'75460'	1
CONGENITAL PES PLANUS	'75461'	1
TALIPES CALCANEOVALGUS	'75462'	1
CONG VALG FOOT DEF NEC	'75469'	1
TALIPES NOS	'75470'	1
TALIPES CAVUS	'75471'	1
CONG FOOT DEFORM NEC	'75479'	1
PECTUS EXCAVATUM	'75481'	1
PECTUS CARINATUM	'75482'	1
NONTERATOG ANOM NEC	'75489'	1
POLYDACTYLY- FINGERS	'75501'	1

SYNDACTYL FING-NO FUSION	'75511'	1
SYNDACTYL TOE-NO FUSION	'75513'	1
TRANSVERSE DEFIC ARM	'75521'	1
LONGITUDINAL DEFIC ULNA	'75527'	1
LONGITUDINAL DEFIC HAND	'75528'	1
LONGITUD DEFIC PHALANGES	'75529'	1
REDUCTION DEFORM LEG NOS	'75530'	1
TIBIOFIBULA LONGIT DEFIC	'75535'	1
LONGITUDINAL DEFIC FOOT	'75538'	1
REDUCT DEFORM LIMB NOS	'7554 '	1
UPPER LIMB ANOMALY NOS	'75550'	1
MADELUNG-s DEFORMITY	'75554'	1
ACCESSORY CARPAL BONES	'75556'	1
UPPER LIMB ANOMALY NEC	'75559'	1
LOWER LIMB ANOMALY NOS	'75560'	1
CONG HIP DEFORMITY NEC	'75563'	1
CONG KNEE DEFORMITY	'75564'	1
ANOMALIES OF TOES NEC	'75566'	1
ANOMALIES OF FOOT NEC	'75567'	1
LOWER LIMB ANOMALY NEC	'75569'	1
CONGEN LIMB ANOM NEC	'7558 '	1
CONGEN LIMB ANOM NOS	'7559 '	1
ANOMAL SKULL/FACE BONES	'7560 '	1
ANOMALY OF SPINE NOS	'75610'	1
LUMBOSACR SPONDYLOLYSIS	'75611'	1
SPONDYLOLISTHESIS	'75612'	1
CONGEN FUSION OF SPINE	'75615'	1
KLIPPEL-FEIL SYNDROME	'75616'	1
SPINA BIFIDA OCCULTA	'75617'	1
ANOMALY OF SPINE NEC	'75619'	1
CERVICAL RIB	'7562 '	1
RIB & STERN ANOMAL NEC	'7563 '	1
CHONDRODYSTROPHY	'7564 '	1
OSTEOGENESIS IMPERFECTA	'75651'	1
OSTEOPOIKILOSIS	'75653'	1
POLYOSTOTIC FIBROS DYSPL	'75654'	1
MULT EPIPHYSEAL DYSPLAS	'75656'	1
OSTEODYSTROPHY NEC	'75659'	1
ANOMALIES OF DIAPHRAGM	'7566 '	1
CONG ANOM PRUNE BELLY SYND	'75671'	1
OT CONG ANOM ABD WALL	'75679'	1

ACCESSORY MUSCLE	'75682'	1
EHLERS-DANLOS SYNDROME	'75683'	1
SOFT TISSUE ANOMALY NEC	'75689'	1
MUSCULOSKEL ANOM NEC/NOS	'7569 '	1
HERED EDEMA OF LEGS	'7570 '	1
ICHTHYOSIS CONGENITA	'7571 '	1
DERMATOGLYPHIC ANOMALIES	'7572 '	1
CONG ECTODERMAL DYSPLAS	'75731'	1
VASCULAR HAMARTOMAS	'75732'	1
CONG SKIN PIGMENT ANOMAL	'75733'	1
SKIN ANOMALY NEC	'75739'	1
HAIR ANOMALIES NEC	'7574 '	1
NAIL ANOMALIES NEC	'7575 '	1
BREAST ANOMALIES NEC	'7576 '	1
OTH INTEGUMENT ANOMALIES	'7578 '	1
INTEGUMENT ANOMALY NOS	'7579 '	1
DOWN-s SYNDROME	'7580 '	1
PATAU-s SYNDROME	'7581 '	1
EDWARD-s SYNDROME	'7582 '	1
AUTOSOMAL DEL SYND	'7583 '	1
VELO-CARDIO-FACIAL SYND	'75832'	1
MICRODELETIONS NEC	'75833'	1
AUTOSOMAL ANOM NEC	'7585 '	1
GONADAL DYSGENESIS	'7586 '	1
KLINEFELTER-s SYNDROME	'7587 '	1
OTH CHROMOSOM ANOM	'75889'	1
CHROMOS ANOMALY NOS	'7589 '	1
ANOMALIES OF SPLEEN	'7590 '	1
ADRENAL GLAND ANOMALY	'7591 '	1
ENDOCRINE ANOMALY NEC	'7592 '	1
SITUS INVERSUS	'7593 '	1
TUBEROUS SCLEROSIS	'7595 '	1
HAMARTOSES NEC	'7596 '	1
MULT CONG ANOMAL NEC	'7597 '	1
PRADER-WILLI SYNDROME	'75981'	1
MARFAN SYNDROME	'75982'	1
FRAGILE X SYNDROME	'75983'	1
SPEC CONG ANOMAL NEC	'75989'	1
CONGENITAL ANOMALY NOS	'7599 '	1
HX OTH CONG ANOM	'V1369'	1

Appendix 3. Modifications to Hwang-Naessens' Chronic Conditions

The 62 conditions categories (excluding diabetes) used in this study were developed to represent a comprehensive set of diabetes- and outpatient-relevant chronic conditions, encompassing 1,981 ICD-9 codes. They are based on a set of conditions developed and used in previous health services research.[30,31] Hwang et al used a physician panel to categorize conditions that were reported by participants in the Medical Expenditures Panel Survey (MEPS) as chronic or not. Chronic conditions were then grouped into mutually exclusive condition categories using the Agency for Healthcare Research and Quality (AHRQ) clinical classification system (CCS) categories. The Hwang chronic condition classifications are now used as the basis for the AHRQ Health Care Utilization Project chronic condition indicator[173] and the AHRQ chronic conditions chart book.[2] Naessens et al modified the list developed by Hwang to include additional conditions found in the patients in the Naeesens' study sample and not included in the original Hwang list. [30,31]

For this study, the chronic condition categories was further modified to enhance the representation of cardiovascular, metabolic and mental health conditions, as these conditions are especially relevant to diabetes care. Names were also changed for clinical clarification. Changes to the Hwang-Naessens' conditions are listed below.

Table A3. Modifications to Previous Chronic Condition Categories to Better represent Cardiovascular, Metabolic and Mental Health Conditions

Hwang-Naessens category name	Magnan category name	Type of change	Diagnoses Changes
Other and ill-defined heart disease	Cardiomyopathy and Structural Heart Disease	rename, separated into different categories	Move to "coronary atherosclerosis": ASCVD; Move to "aneurysm": aneurysm-heart (wall), coronary vessel aneurysm, dissection of coronary artery (Begin 2002), aneurysm of heart NEC.
peripheral vascular disease	peripheral vascular disease	add diagnoses	Add: PERIPHERAL VASCULAR DIS NEC, CHR VASC INSUFF INTEST, VASC INSUFF INTEST NOS; Move to "other central and peripheral nervous system disorders": NEUROPATHY IN DIABETES,NEUROPATHY IN OTHER DIS, CHRONIC INFLAMM DEMYELINATING PLYNEUR
other vascular	non-thrombotic, non-atherosclerotic vascular disease	rename, separate into 2 categories	Move to "peripheral vascular disease": periph vasc dis NEC; Move to "Thrombosis and embolism": ABD AORTIC EMBOLISM, THORACIC AORTIC EMBOLISM, THORACIC AORTIC EMBOLISM, UPPER EXTREMITY EMBOLISM, LOWER EXTREMITY EMBOLISM, ILIAC ARTERY EMBOLISM, ARTERIAL EMBOLISM NEC, ARTERIAL EMBOLISM NOS, THROMBOANGIIT OBLITERANS
(same)	Thrombosis and Embolism	new category	Add: ABD AORTIC EMBOLISM, THORACIC AORTIC EMBOLISM, THORACIC AORTIC EMBOLISM, UPPER EXTREMITY EMBOLISM, LOWER EXTREMITY EMBOLISM, ILIAC ARTERY EMBOLISM, ARTERIAL EMBOLISM NEC, ARTERIAL EMBOLISM NOS, THROMBOANGIIT OBLITERANS
congenital anomaly	non-cardiac congenital disorder	split category into 2	Remove congenital heart disease codes
(same)	congenital heart disease	new category	Add congenital heart disease codes
other mental	(no name) (re-organized into other categories)	split into other categories	
behavior problem	Behavioral Disorders	change diagnoses to separate anxiety, depression and sleep disorders	Move to "Anxiety Disorders": Anorexia Nervosa, Eating disorder NOS, Bulimia, Pica, Psychogenic rumination, Eating Disorder NEC; Move to "Sleep Disorders": NONORGANIC SLEEP DIS NOS, PERSISTENT INSOMNIA, PERSISTENT HYPERSOMNIA; DISRUPT SLEEP-WAKE CYCLE; SOMNAMBULISMNGHT TERROR; SLEEP STAGE DYSFUNC NEC; REPETIT SLEEP INTRUSION;

			NONORGANIC SLEEP DIS NEC
anxiety	Anxiety Disorders	add diagnoses from previous "other mental" and "personality disorders"	Add: Neurotic disorder NOS, Identity disorder, Conversion disorder, Psychogenic amnesia, dissociative react nos, somatization disorder, somatoform dis NOS Oct96--
	Sleep Disorders	new category, add diagnoses from previous behavior problem	Add: NONORGANIC SLEEP DIS NOS, PERSISTENT INSOMNIA, PERSISTENT HYPERSOMNIA; DISRUPT SLEEP-WAKE CYCLE; SOMNAMBULISMNGHT TERROR; SLEEP STAGE DYSFUNC NEC; REPETIT SLEEP INTRUSION; NONORGANIC SLEEP DIS NEC ; narcolepsy
	Schizophrenia and Psychotic Disorders (excluding mood disorders)	new category, add diagnoses	Add: CHILD PSYCHOS NEC-ACTIVE, CHILD PSYCHOS NEC-RESID, CHILD PSYCHOS NOS-ACTIVE, ICD 9 29500-29592, ICD 9 2971,2979, 2980-2989
Personality disorder	Personality and psychogenic disorders	change diagnoses	Add: all from "Other mental", CHR DEPRESSIVE PERSON; Move to "Anxiety Disorders": Neurotic disorder NOS, Identity disorder, Conversion disorder, Psychogenic amnesia, dissociative react nos, somatization disorder, somartoform dis NOS Oct96--; Move to "Schizophrenia and Psychoses": CHILD PSYCHOS NEC-ACTIVE, CHILD PSYCHOS NEC-RESID, CHILD PSYCHOS NOS-ACTIVE; ICD 9 29500-29592, ICD 9 2980-2989; Move to "Bipolar Disorder": ICD 9 codes 29600-29699, CYCLOTHYMIC DISORDER
Depression	(no change)	separate bipolar and personality disorders	Move to "Bipolar Disorder": MANIC-DEPRESSIVE NOS, MANIC-DEPRESSIVE NEC; Move to "Personality and psychogenic disorders": CHR DEPRESSIVE PERSON;
	Bipolar Disorder	new category, add diagnoses	Add: MANIC-DEPRESSIVE NOS, MANIC-DEPRESSIVE NEC, ICD 9 codes 29600-29699, CYCLOTHYMIC DISORDER;
Substance-related disorder	Substance-use Disorders	removed physical diagnoses resulting from substance abuse	Move to "hepatitis": ALCHOL FATTY LIVER, ACUTE ALCOHOL HEPATITIS, ALCOHOL CIRRHOSIS LIVER, ALCOHOL LIVER DAMAGE UNSPEC ; Move to "central and peripheral nervous system disorders": ALCOHOL POLYNEUROPATHY

ovarian, uterine and reproductive	Female infertility and GU anatomic disorders (eg prolapse, endometriosis)	rename, separate into 3 categories	Move to "polycystic ovarian syndrome": polycystic ovarian syndrome (2564); Move to "menopause" : PREMATURE MENOPAUSE (Begin 2001), OTHER OVARIAN FAILURE (Begin 2001), PREMENOPAUSE MENORRHAGIA, POSTMENOPAUSAL BLEEDING, FEMALE CLIMACTERIC STATE, ATROPHIC VAGINITIS, ARTIFIC MENOPAUSE STATES, MENOPAUSAL DISORDER NEC, MENOPAUSAL DISORDER NOS
(same)	Menopause and Perimenopause	new category	Add: PREMATURE MENOPAUSE (Begin 2001), OTHER OVARIAN FAILURE (Begin 2001), POSTMENOPAUSAL BLEEDING, FEMALE CLIMACTERIC STATE, ATROPHIC VAGINITIS, ARTIFIC MENOPAUSE STATES, MENOPAUSAL DISORDER NEC, MENOPAUSAL DISORDER NOS
(same)	polycystic ovarian syndrome	new category	Add: polycystic ovarian syndrome
pancreatitis, amyloidosis, sarcoidosis	chronic pancreatitis	split category into 3	Should contain only: CHRONIC PANCREATITIS, PANCREATIC DISEASE NEC, PANCREATIC STEATORRHEA
(same)	amyloidosis	new category	should contain only: AMYLOIDOSIS, AMYLOIDOSIS NOS , AMYLOIDOSIS NEC
(same)	sarcoidosis	new category	SARCOIDOSIS
other central nervous system disorder	Other central and peripheral nervous system disorders	rename, add diagnoses from other categories	Add: NEUROPATHY IN OTHER DIS, ALCOHOL POLYNEUROPATHY;
other kidney disease	Kidney and Vesicoureteral Disorders (excluding renal failure)	rename	
hepatitis	Chronic Hepatitis	rename	Add: ALCHOL FATTY LIVER, ACUTE ALCOHOL HEPATITIS, ALCOHOL CIRRHOSIS LIVER, ALCOHOL LIVER DAMAGE UNSPEC
chronic liver disease	Chronic Liver Disease (excluding chronic hepatitis)	rename	
diverticulosis	Diverticulosis, diverticulitis, enterocolitis, intestinal malabsorption	name change	
major intestinal disorder	n/a	delete category- move diagnoses to other categories	Remove: acute vascular insufficiency code Move to "diverticulosis": CELIAC DISEASE, TROPICAL SPRUE, BLIND LOOP SYNDROME, INTEST MALABSORPTION NEC,INTEST MALABSORPTION NOS ; Move to "peripheral vascular": CHR VASC INSUFF INTEST, VASC INSUFF INTEST NOS

Appendix 4. Delphi Survey for Paper 1.

Figure A4. Delphi Chronic Conditions and Care Goals Survey, as Sent to Providers through the Web-Based Qualtrics Platform for Paper 1.

Please identify if, in your practice, the following care is indicated for a typical adult patient who has each specific chronic condition. Assume that the patient has only this chronic condition. Please click only where you would typically undertake the proposed care management strategy.

Cardiac, vascular and pulmonary conditions

	Tobacco cessation counseling: Click if indicated	Blood pressure management: Click if indicated	LDL cholesterol management: Click if indicated	Kidney function monitoring: Click if indicated	Annual eye exam: Click if indicated	Blood sugar management: Click if indicated
Acute myocardial infarction in past 2 years	☐	☐	☐	☐	☐	☐
Congestive heart failure	☐	☐	☐	☐	☐	☐
Coronary atherosclerosis	☐	☐	☐	☐	☐	☐
Peripheral atherosclerosis	☐	☐	☐	☐	☐	☐
Hyperlipidemia	☐	☐	☐	☐	☐	☐
Hypertension	☐	☐	☐	☐	☐	☐
Conduction disorder or cardiac dysrhythmia	☐	☐	☐	☐	☐	☐
Heart valve disorder	☐	☐	☐	☐	☐	☐
Congenital heart disease	☐	☐	☐	☐	☐	☐
Cerebrovascular disease	☐	☐	☐	☐	☐	☐
Aneurysm	☐	☐	☐	☐	☐	☐
Cardiomyopathy and structual heart disease	☐	☐	☐	☐	☐	☐
Non-thrombotic, non-athlerosclerotic vascular disease	☐	☐	☐	☐	☐	☐
Pulmonary heart disease	☐	☐	☐	☐	☐	☐
Asthma or chronic obstructive pulmonary disease	☐	☐	☐	☐	☐	☐
Thrombosis and embolism	☐	☐	☐	☐	☐	☐

Gastrointestinal conditions

	Tobacco cessation counseling: Click if indicated	Blood pressure management: Click if indicated	LDL cholesterol management: Click if indicated	Kidney function monitoring: Click if indicated	Annual eye exam: Click if indicated	Blood sugar management: Click if indicated
Chronic liver disease (excluding chronic hepatitis)	☐	☐	☐	☐	☐	☐
Chronic hepatitis	☐	☐	☐	☐	☐	☐
Diverticulosis, diverticulitis, enterocolitis, and intestinal malabsorption	☐	☐	☐	☐	☐	☐
Esophageal disorder	☐	☐	☐	☐	☐	☐
Chronic pancreatitis	☐	☐	☐	☐	☐	☐

Genitourinary conditions

	Tobacco cessation counseling: Click if indicated	Blood pressure management: Click if indicated	LDL cholesterol management: Click if indicated	Kidney function monitoring: Click if indicated	Annual eye exam: Click if indicated	Blood sugar management: Click if indicated
Chronic renal failure	☐	☐	☐	☐	☐	☐
Kidney and vesicoureteral disorders (excluding renal failure)	☐	☐	☐	☐	☐	☐
Benign prostatic hypertrophy	☐	☐	☐	☐	☐	☐
Polycystic ovarian syndrome	☐	☐	☐	☐	☐	☐
Female infertility and GU anatomic disorders (e.g. prolapse, endometriosis)	☐	☐	☐	☐	☐	☐
Menopause and perimenopause	☐	☐	☐	☐	☐	☐

Allergies, immune system conditions, and infectious disease

	Tobacco cessation counseling: Click if indicated	Blood pressure management: Click if indicated	LDL cholesterol management: Click if indicated	Kidney function monitoring: Click if indicated	Annual eye exam: Click if indicated	Blood sugar management: Click if indicated
Allergic rhinitis	☐	☐	☐	☐	☐	☐
Immunity disorder	☐	☐	☐	☐	☐	☐
Lupus	☐	☐	☐	☐	☐	☐
Rheumatoid arthritis	☐	☐	☐	☐	☐	☐
Tuberculosis	☐	☐	☐	☐	☐	☐
Human immunodeficiency virus	☐	☐	☐	☐	☐	☐

Neurological conditions

	Tobacco cessation counseling: Click if indicated	Blood pressure management: Click if indicated	LDL cholesterol management: Click if indicated	Kidney function monitoring: Click if indicated	Annual eye exam: Click if indicated	Blood sugar management: Click if indicated
Paralysis	☐	☐	☐	☐	☐	☐
Epilepsy	☐	☐	☐	☐	☐	☐
Migraines	☐	☐	☐	☐	☐	☐
Multiple sclerosis	☐	☐	☐	☐	☐	☐
Organic brain problem (dementia)	☐	☐	☐	☐	☐	☐
Parkinson's disease	☐	☐	☐	☐	☐	☐
Other central and peripheral nervous system disorders	☐	☐	☐	☐	☐	☐

Muscoskeletal conditions

	Tobacco cessation counseling: Click if indicated	Blood pressure management: Click if indicated	LDL cholesterol management: Click if indicated	Kidney function monitoring: Click if indicated	Annual eye exam: Click if indicated	Blood sugar management: Click if indicated
Back problem	☐	☐	☐	☐	☐	☐
Osteoarthritis	☐	☐	☐	☐	☐	☐
Gout or other crystal arthropathy	☐	☐	☐	☐	☐	☐

Hematologic conditions and cancer

	Tobacco cessation counseling: Click if indicated	Blood pressure management: Click if indicated	LDL cholesterol management: Click if indicated	Kidney function monitoring: Click if indicated	Annual eye exam: Click if indicated	Blood sugar management: Click if indicated
Anemia	☐	☐	☐	☐	☐	☐
Sickle cell anemia	☐	☐	☐	☐	☐	☐
Malignant neoplasm	☐	☐	☐	☐	☐	☐

Behavioral and mental health conditions

	Tobacco cessation counseling: Click if indicated	Blood pressure management: Click if indicated	LDL cholesterol management: Click if indicated	Kidney function monitoring: Click if indicated	Annual eye exam: Click if indicated	Blood sugar management: Click if indicated
Anxiety disorders	☐	☐	☐	☐	☐	☐
Depression	☐	☐	☐	☐	☐	☐
Bipolar disorder	☐	☐	☐	☐	☐	☐
Substance-use disorders	☐	☐	☐	☐	☐	☐
Personality and psychogenic disorders	☐	☐	☐	☐	☐	☐
Schizophrenia and psychotic disorders (excluding mood disorders)	☐	☐	☐	☐	☐	☐
Sleep disorders	☐	☐	☐	☐	☐	☐
Behavioral disorders	☐	☐	☐	☐	☐	☐

Other conditions

	Tobacco cessation counseling: Click if indicated	Blood pressure management: Click if indicated	LDL cholesterol management: Click if indicated	Kidney function monitoring: Click if indicated	Annual eye exam: Click if indicated	Blood sugar management: Click if indicated
Obesity	☐	☐	☐	☐	☐	☐
Chronic skin ulcer	☐	☐	☐	☐	☐	☐
Degenerative eye problem	☐	☐	☐	☐	☐	☐
Thyroid disorder	☐	☐	☐	☐	☐	☐
Amyloidosis	☐	☐	☐	☐	☐	☐
Sarcoidosis	☐	☐	☐	☐	☐	☐
Cystic fibrosis	☐	☐	☐	☐	☐	☐
Non-cardiac congenital anomaly	☐	☐	☐	☐	☐	☐

Appendix 5. Method of Chronic Condition Identification

Each patient's chronic conditions were identified in the baseline year, 2011, using the 62 chronic conditions (excluding diabetes) listed in Appendix 1. The baseline year was chosen to ensure that the condition was present and potentially distracting or supporting for the entire diabetes quality metrics reporting year. Conditions were identified if they were billed during an E&M visit in the baseline year to ensure that the condition was active and currently managed, rather than historical as could be the case with conditions that were present in past years or a problem list only. The code needed to be billed at only one visit to be considered present and active; a single code rather than 2 or more was chosen to fully count conditions as many patients might only be seen once in a year for that condition, and requiring two or more codes for the condition might incorrectly miss potentially distracting or supporting conditions.

An algorithm identified the ICD-9 codes billed at each E&M visit in the baseline year. If any of the ICD-9 codes for one of the 62 chronic conditions were billed in the baseline year (see Appendix 2 for the ICD-9 codes), the chronic condition indicator was 1. If one of the ICD-9 codes for the condition was not billed, the indicator for that condition was 0. If multiple ICD-9 codes for the same chronic condition category were billed over the year, the chronic condition was 1 (condition present).

For paper 2, variables representing the count of total, concordant and discordant conditions were used determined from a sum of all total, all concordant and all discordant condition indicators. For paper 3, the individual indicators were used.

Appendix 6. Method of Diabetes Quality Metric Measurement

Diabetes quality metric achievement was measured as achieved or not achieved in the reporting year using Wisconsin Collaborative for Healthcare Quality measures from 2011 (the reporting year) that are based on the American Diabetes Associations Guidelines for 2011.[61,140]

HbA1c testing: The HbA1c testing variable is binary based on the number of HbA1c tests received during the measurement year (1=the recommended 2 or more, 0=suboptimal 1 or none). HbA1c tests are determined by laboratory results for HbA1c found in the patient's chart during the measurement year, or claims during the measurement year for the following codes:[174]

Table A6.1 HbA1c Testing Codes

Source of Code	Code	Description
CPT	83036	HbA1c
	83037	HbA1c by point-of-care testing
LOINC	4548-4, 17856-6, 59261-8, 62388-A	HbA1c total in blood

HbA1c control: The HbA1c control variable has two categories, controlled (1) or not controlled (0), based on the most recent HbA1c value during the measurement year: controlled: <7.0% or <8.0% for high-risk patients (age> 70, specific comorbidities per the ADA) or not controlled.[61]

Blood pressure control: Blood pressure control is considered adequate if the most recent blood pressure reading in the patient's chart during the reporting year is < 130/80 (2011 standards).[61]

LDL cholesterol testing: The LDL cholesterol testing variable is based on adequate testing in the past year (1=adequate 1 or more tests completed, 0=suboptimal no tests completed). LDL cholesterol tests are determined by presence of a result in the system, or an LDL cholesterol test as identified by claims the following codes:[61]

Table A6.2 LDL Cholesterol Testing Codes

Source of Code	Code	Description
CPT	83721	LDL by direct measurement
	80061	Lipid panel including LDL by direct measurement
	83700	Lipoprotein, blood; electrophoretic separation and quantitation
	83701	Lipoprotein cholesterols by High resolution fractionation and quantitation
	82465, 83718 AND 84478 on the same claim	Lipid panel including Total cholesterol, HDL cholesterol and triglycerides
LOINC	2089-1, 12773-8, 13457-7, 18261-8, 18262-6, 22748-8, 39469-2	LDL by different assay techniques or in different units
	24331-1	lipid panel

LDL cholesterol control: The LDL cholesterol control variable is adequate at <100, or suboptimal ≥ 100, in the measurement year.[61]

Kidney testing: This variable represents appropriate kidney testing for microalbuminuria in the reporting year. Appropriate kidney testing is determined by the presence of a microalbuminuria test with result in the measurement year. Patients with evidence of diagnosed kidney disease during the measurement year are also considered to have appropriate testing done without needing a lab result for microalbuminuria (1=tested or diagnosed with nephropathy, 0= not tested and not diagnosed). The codes to identify testing are:[61]

Table A6.3 Kidney Testing Codes

Source of Code	Code	Description
CPT	82042	Serum albumin; urine or other source, quantitative, each specimen
	82043	Serum albumin; urine, micro albumin, quantitative
	82044	Serum albumin; urine, micro albumin, semi quantitative (e.g., reagent strip assay)
	84156	Protein, total, except by refractometry, urine
LOINC	1753-3, 1754-1, 1755-8, 1757-4, 2887-8, 2888-6, 2889-4, 2890-2, 9318-7, 11218-5, 12842-1,13801-6, 14956-7, 14957-5, 14958-3, 14959-1, 13705-9, 14585-4, 18373-1, 20621-9, 21059-1, 21482-5, 26801-1, 27298-9, 30000-4, 30001-2, 30003-8, 32209-9, 32294-1, 32551-4, 34366-5, 35663-4, 40486-3, 40662-9, 40663-7, 43605-5, 43606-3, 43607-1, 44292-1, 47558-2, 49023-5, 50949-7, 53121-0, 53530-2, 53531-0, 53532-8, 56553-1, 57369-1, 58992-9, 59159-4	Assorted tests for albumin or protein in the urine, different units and/or measurement periods (*i.e.*, spot, 24 hour)

Evidence of diagnosed nephropathy include: diagnoses or treatment for nephropathy during the measurement year or a visit to nephrologist for any reason during the

measurement year. A positive (greater than trace) gross proteinuria test during the measurement year also qualifies as a diagnosis of nephropathy, identified with CPT codes: 81000-81003 and 81005 or LOINC 57735-3.[61]

All Testing: A patient qualifies for this metric if the patient meets criteria for adequate HbA1c, LDL cholesterol and kidney testing in the reporting year. Also called All-or-None Testing.

All Testing: A patient qualifies for this metric if the patient meets criteria for adequate HbA1c, LDL cholesterol and blood pressure control in the reporting year. Also called All-or-None Control.

Appendix 7. Statistical Model Selection for Paper 2

The final models used in Paper 2 are the result of logistic regression model fit testing described in this Appendix.

The overall model was:

$$P[Y=1|C, D, V] = \beta_0 + \beta_1(C) + \beta_2(D) + \beta_3(V) + \varepsilon$$

where:
Y= diabetes care goal achievement (for each of the 8 diabetes care goals)
C= count of goal-concordant comorbid conditions (for that diabetes care goal)
D= count of goal-discordant comorbid conditions (for that diabetes care goal)
V= vector of time-invariant patient co-variates

The model selection described below was done to determine if linear, ordinal or categorical variables should be used for C and D above, and if an interaction term should be added to improve model fit.

MODEL SELECTION

The ideal model for this study is clinically meaningful, statistically satisfactory and as simple as possible without losing meaning. The following models were tested and compared to each other as listed. Indicator (categorical) and ordinal variables with different levels for concordant condition and discordant condition counts were tested in different combinations.

Models are adjusted for health system. This approach, rather than clustering by health system with a robust standard error, was chosen as the number of health systems and number of patients would results in too few and too large of clusters.

All models are fully adjusted for the co-variates in Paper 2, including visit count.

Models tested:

1- concordant ordinal (1,2,3,4,5,6+) and discordant ordinal (1,2,3,4,5,6+)

2- concordant indicators (0,1,2,3,4,5,6+) and discordant ordinal (1,2,3,4,5,6+)

3- concordant indicators (0,1,2,3,4,5,6+) and discordant ordinal s (1,2,3,4,5,6+) with interaction concordant (cat)*disc(ordinal)

4- concordant indicators (0-1,2-3,4-5,6+) and discordant ordinal (1,2,3,4,5,6+)

5- concordant indicators (0-1,2-3,4-5,6+) and discordant ordinal (1,2,3,4,5,6+) with interaction concordant (indicators)* discordant (ordinal)

6- concordant indicators (0,1,2,3,4,5,6+) and discordant indicators (01 vs 2+)

7- concordant indicators (0,1,2,3,4,5,6+) and discordant indicators (01 vs 2+) with interaction concordant (indicators) * disc (indicators)

8- concordant indicators (0-1,2-3,4-5,6+) and discordant indicators (01 vs 2+)

9- concordant indicators (0-1,2-3,4-5,6+) and discordant indicators (01 vs 2+) with interaction concordant (indicators)* discordant (indicators)

10-concordant indicators (01 vs 2+) and discordant indicators (01 vs 2+)

11-concordant indicators (01 vs 2+) and discordant indicators (01 vs 2+) with interaction concordant (indicators)* discordant (indicators)

Comparisons:

I calculated and compared BIC and c-statistic for each model, for each diabetes care goal outcome, to examine difference and any loss in meaning between models. I specifically compared models without interaction to the same model with interaction (e.g., Model 9 to Model 8), and progressively simpler models to the more complex models (by main effects variable type) (e.g., Model 8 to Model 10).

Table A7. Model Selection: Results of 11 Potential Models to Explain the Impact of the Concordant and Discordant Condition Count on Diabetes Care Goal Achievement

Model	Concordant variable	Discordant variable	BIC	c-statistic
A1c Testing				
1	continuous (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	26434	0.6504
2	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	26464	0.6515
3	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	26829	0.6534
4	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	26451	0.6502
5	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	26648	0.6514
6	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	26470	0.6513
7	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	26516	0.6518
8	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	26457	0.6499
9	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	26479	0.6502
10	indicator (01 vs 2+)	indicator (01 vs 2+)	26463	0.6489
11	indicator (01 vs 2+)	indicator (01 vs 2+)	26461	0.6492
LDL Testing				
1	continuous (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	17146	0.6804
2	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	17142	0.6853
3	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	17495	0.6906
4	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	17140	0.6836
5	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	17343	0.6864
6	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	17146	0.6849
7	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	17197	0.6859
8	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	17143	0.6833
9	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	17171	0.6835
10	indicator (01 vs 2+)	indicator (01 vs 2+)	17130	0.6828
11	indicator (01 vs 2+)	indicator (01 vs 2+)	17137	0.6831

Model	Concordant variable	Discordant variable	BIC	c-statistic
A1c Control				
1	continuous (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	28704	0.6989
2	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	28728	0.6999
3	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	29087	0.7021
4	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	28727	0.6985
5	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	28936	0.6995
6	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	28739	0.6995
7	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	28795	0.6997
8	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	28740	0.6981
9	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	28766	0.6983
10	indicator (01 vs 2+)	indicator (01 vs 2+)	28735	0.697
11	indicator (01 vs 2+)	indicator (01 vs 2+)	28744	0.6971
LDL Control				
1	continuous (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	31228	0.6238
2	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	31248	0.6252
3	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	31618	0.6273
4	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	31235	0.6242
5	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	31445	0.6253
6	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	31249	0.6252
7	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	31305	0.6255
8	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	31236	0.6242
9	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	31265	0.6242
10	indicator (01 vs 2+)	indicator (01 vs 2+)	31237	0.6228
11	indicator (01 vs 2+)	indicator (01 vs 2+)	31247	0.6228

Model	Concordant variable	Discordant variable	BIC	c-statistic
Kidney Test				
1	continuous (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	23210	0.6319
2	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	23222	0.6336
3	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	23568	0.637
4	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	23255	0.6272
5	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	23435	0.6298
6	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	23222	0.6335
7	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	23258	0.6351
8	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	23255	0.6273
9	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	23262	0.6291
10	indicator (01 vs 2+)	indicator (01 vs 2+)	23372	0.6198
11	indicator (01 vs 2+)	indicator (01 vs 2+)	23356	0.622
All Test				
1	continuous (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	30686	0.6325
2	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	30717	0.6335
3	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	31064	0.6367
4	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	30728	0.6306
5	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	30919	0.6326
6	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	30715	0.6337
7	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	30754	0.6348
8	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	30726	0.6308
9	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	30746	0.6313
10	indicator (01 vs 2+)	indicator (01 vs 2+)	30771	0.6275
11	indicator (01 vs 2+)	indicator (01 vs 2+)	30768	0.6282

Model	Concordant variable	Discordant variable	BIC	c-statistic
BP Control				
1	continuous (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	32529	0.565
2	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	32526	0.5704
3	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	32884	0.5748
4	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	32513	0.569
5	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	32710	0.5716
6	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	32526	0.5705
7	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	32579	0.5713
8	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	32512	0.5691
9	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	32536	0.5697
10	indicator (01 vs 2+)	indicator (01 vs 2+)	32500	0.5681
11	indicator (01 vs 2+)	indicator (01 vs 2+)	32507	0.5684
All Control				
1	continuous (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	23847	0.6459
2	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	23893	0.646
3	indicators (0,1,2,3,4,5,6+)	continuous (0,1,2,3,4,5,6+)	24247	0.65
4	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	23867	0.6458
5	indicators (0-1,2-3,4-5,6+)	continuous (0,1,2,3,4,5,6+)	24069	0.6478
6	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	23894	0.646
7	indicators (0,1,2,3,4,5,6+)	indicator (01 vs 2+)	23946	0.6467
8	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	23868	0.6458
9	indicators (0-1,2-3,4-5,6+)	indicator (01 vs 2+)	23894	0.6462
10	indicator (01 vs 2+)	indicator (01 vs 2+)	23860	0.6446
11	indicator (01 vs 2+)	indicator (01 vs 2+)	23870	0.6447

After review of the results in the above table, I decided to not use an interaction term as it is rejected by BIC, as BIC imposes a punishment for added parameters with a large sample size, and the c-statistic does not vary much with and without interaction suggesting minimal added value to the interaction. Interaction terms add complexity to the clinical interpretation as well.

The best model varied slightly for each diabetes care goal outcome, although the models did not different by much, Model 8 was a bit better or equal to other models for all but 2 outcomes (HbA1c control and kidney test), and was satisfactory for all outcomes.

With Model 8, the 95% confidence intervals for 4-5 concordant conditions and 6+ concordant conditions overlapped for all outcomes except kidney testing (which also had overlap for 4-6+ conditions in Model 2). Based on this, I collapsed the 2 top categories into one, creating 3 concordant categories: 0-1,2-3 and 4+. For consistency between the concordant and discordant conditions, I used the same 3 categories for discordant conditions.

My final model was: concordant condition indicators (categories) (0-1,2-3,4+) and discordant condition indicators (categories) (0-1,2-3,4+).

Appendix 8. Statistical Model Selection for Paper 3

For paper 3, the 6 initial statistical models were fit with all 62 chronic condition indicators in the model for each of the 6 main diabetes control goals as the outcomes (HbA1c testing, LDL cholesterol testing, kidney testing, HbA1c control, LDL cholesterol control, blood pressure control). These models were adjusted for the co-variates in Paper 3.

$$P[Y=1|M_1,\ldots,M_{62}, V] = \beta_0 + \beta_1(M_1) + \beta_2(M_2) +\ldots+ \beta_{62}(M_{62}) + \beta_{63}(V) + \varepsilon$$

where:

Y= diabetes care goal achievement (for each of the 6 diabetes care goals)

M_1-M_{62}= presence of chronic conditions 1-62

V= vector of time-invariant patient co-variates

The results (odds ratios and 95% confidence intervals) were examined for significance of each condition for each outcome. Conditions that were not significant for at least 1 testing goal were removed from further analysis of testing goals, and conditions that were not significant for at least 1 control goal were removed from further analysis for control goals. These conditions were presented in the results for Paper 3 as not significant for testing and/or control goals.

Two subsequent sets of models were fit, one set for the testing goals and one set for the control goals. The conditions that were significant for at least 1 of the testing goals were included in the models fit for each of the 3 testing goals (3 models were fit, 1 for each testing goal outcome, with the same conditions in all 3 models).

$$P[Y=1|M_{T1},\ldots,M_{Tx}, V] = \beta_0 + \beta_1(M_{T1}) + \beta_2(M_{T2}) +\ldots+ \beta_x(M_{Tx}) + \beta_{x+1}(V) + \varepsilon$$

where:

Y= diabetes testing care goal achievement (for each of the 3 testing care goals)

M_{T1}-M_{Tx}= presence of chronic conditions significant to at least 1 testing goal

V= vector of time-invariant patient co-variates

The conditions that were significant for at least 1 of the control goals were included in models fit for each of the 3 control goals (3 models were fit, 1 for each control goal outcome, with the same conditions in all 3 models).

$$P[Y=1|M_{C1},\ldots,M_{Cx}, V] = \beta_0 + \beta_1(M_{C1}) + \beta_2(M_{C2}) +\ldots+ \beta_x(M_{Cx}) + \beta_{x+1}(V) + \varepsilon$$

where:

Y= diabetes control care goal achievement (for each of the 3 control care goals)

M_{C1}-M_{Cx}= presence of chronic conditions significant to at least 1 control goal

V= vector of time-invariant patient co-variates

After this second set of models, congenital heart disease was no longer significant for any testing or control goals, and was placed in the not significant list. HIV was no longer significant for control (previously was not significant for testing only) and was also placed in the not significant list. No other conditions lost significance. The odds ratios and confidence intervals from these 6 models are shown in the results in Paper 3.

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