MANAGING FOR IMPROVED HEALTH OUTCOMES, REDUCED COSTS AND REDUCED UTILIZATION IN TYPE 2 DIABETIC PATIENTS

By

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A dissertation submitted in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY
(Individual Interdisciplinary)

WASHINGTON STATE UNIVERSITY
The Graduate School

MAY 2004
To the Faculty of Washington State University:

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Chair

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ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to Dr. Joseph Coyne, the advisor for this work and my committee chair. His dedication of countless hours and research expertise were a tremendous help in completing this thesis. I am very thankful for his willingness to tackle the task of attempting to transform a technician into a scholar.

I would also like to express my gratitude and appreciation to Dr. Paul Schimpf, a committee member for this project. His referral was instrumental in my decision to pursue my research interests. His continuing efforts and guidance in the process of scientific inquiry have directed me toward a career as a scientist.

Finally, and most importantly, I would like to thank my wife Kelsey and my sons Kelvin and Kristopher for their enthusiastic support and dedication to my career goals. Their strength, confidence and love carried me through the most trying times.
MANAGING FOR IMPROVED HEALTH OUTCOMES, REDUCED COSTS AND REDUCED UTILIZATION IN TYPE 2 DIABETIC PATIENTS

Abstract

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May 2004

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Purpose: One of the most prevalent and costly chronic conditions in the U.S. is Type 2 diabetes. Further, both the costs and prevalence of this disease are increasing. Many patients are not even aware they have this disease until complications occur. This study hypothesized preventive screening services (A1C testing, lipids testing, albumin testing, eye exams) in the base year would improve cost, utilization and health outcomes for patients with Type 2 diabetes in the follow-up period of two years.

Methods: Administrative claims data for 3897 patients from a Pacific Northwest health insurance company were analyzed over a 3 year period. Exploratory analysis was conducted using a data mining technique for cluster analysis called self-organizing maps. Following cluster analysis predictive models were built using bivariate correlation and regression analysis. Linear regression models were used for continuous outcome variables for cost and utilization. Logistic regression models were used for dichotomous outcome variables related to the onset of co-morbid disease.

Findings: Many patients with Type 2 diabetes do not receive preventive screenings. This study found no evidence to support an association between preventive screening services and follow-up period costs. Lipid testing in the base year was associated with reductions in
emergency department visits, acute care inpatient admissions and delays in the onset of neuropathy in the follow-up period. A1C testing in the base year was associated with reductions in acute care inpatient admissions and delays in the onset of neuropathy in the follow-up period. Albumin testing was associated with reductions in acute care admissions in the follow-up period.

**Conclusion:** Many patients with Type 2 diabetes receive suboptimal care as evidenced by the lack of preventive screening services. This study found an association between preventive screening services and improvements in utilization and health outcomes. Health care plans and health care providers should increase the rates of preventive screening services for patients with Type 2 diabetes.
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CHAPTER ONE - INTRODUCTION

A consequence of an aging population is the increase in the incidence and prevalence of chronic disease. An estimated one hundred million Americans now have one or more chronic diseases characterized by illness that lasts longer than three months (Hoffman, 1996). More than three-fourths of direct medical care costs in the United States are incurred in the treatment of chronic disease (Hoffman, 1996).

The rising prevalence and cost of chronic diseases require significant changes in the American healthcare system. The current healthcare system is largely based on the construct of acute care illness and often fails to meet the full needs of persons with chronic diseases (Hoffman, 1996). Further, the American healthcare system does not have well-organized programs to provide the full complement of services (e.g. self monitoring and medical management interventions such as peak flow measurements for asthma patients or blood glucose monitoring for diabetic patients) needed by people with chronic diseases (Institute of Medicine, 2001). Disease management programs are one of the key tools that healthcare organizations have used in attempts to control costs and assure quality for patients with chronic disease (Pilnick, 2001).

One of the most prevalent and costly chronic conditions in the U.S. is diabetes mellitus. The Centers for Disease Control and Prevention estimates more than 18 million persons in the U.S. suffered from this disease in 2002 incurring direct medical costs of $92 billion (Centers for Disease Control and Prevention, 2003). More than one in three Americans born in 2000 has a lifetime risk of developing this disease (Narayan, 2003). Men diagnosed with this disease at age 40 lose an average of 11.6 life years while women diagnosed at age 40 lose an average of 14.3 life years (Narayan, 2003). Both the prevalence and economic costs of diabetes mellitus are
expected to increase. Nearly 22 million persons in the U.S. will suffer from this disease by 2025 representing 9% of the U.S. population (King, 1998). By the year 2050, 29 million people are expected to have diabetes mellitus (Boyle, 2001). Given finite resources of the healthcare system, management of this disease will be critical.

The primary goal of disease management includes optimal healthcare outcomes through enhancements in the quality of care provided in an environment of effective cost control (Coons, 1996). Prevention and control programs are pre-requisites to slow the rising epidemic of this disease and its complications (Amos, 1997). The purpose of this empirical study is to assess the effectiveness of such disease management efforts. Specifically, this study examines the use of preventive screening services to manage and control Type 2 diabetes as measured by changes in health outcomes, costs and utilization during the study period.

Management of this disease is designed to reduce costs for health plans and employers. It should be noted however, that the human toll of this disease is devastating. The American Diabetes Association (ADA) reports this disease is the 5th leading cause of death by disease in the United States. Patients with diabetes mellitus carry an increased risk two to four times greater for heart attack, stroke and other complications related to poor circulation (Ragucci, 2003). Diabetic nephropathy has become the leading cause of end-stage renal disease; kidney failure that requires a lifetime of dialysis (Amos, 1997). A very common complication of this disease is damage to nerve endings which may lead to extremity amputations (American Diabetes Association, 2003). One of the most important outcomes of successful disease management efforts is not only decreases in mortality, but decreased rates of morbidity and complications.
Definition and Diagnosis of the Disease

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia (an excess of sugar in the blood) resulting from defects in insulin secretion, insulin action or both (Gavin, 2003).

Symptoms of diabetes mellitus include frequent urination (polyuria), excessive thirst (polydipsia), extreme hunger (polyphagia), unusual weight loss, increased fatigue, irritability and/or blurry vision (American Diabetes Association, 2003). This disease is diagnosed by a blood glucose test when a non-pregnant patient visits a healthcare provider with these symptoms. A diagnosis is confirmed when a casual (any time of day) plasma glucose level exceeds 200 mg/dl, a fasting (no caloric intake for at least 8 hours) plasma glucose is greater than 125 mg/dl, or a 2 hour plasma glucose level is above 200 mg/dl during an oral glucose tolerance test. Because of ease of use, acceptability to patients, and lower cost, the fasting plasma glucose (FPG) is the preferred diagnostic test (American Diabetes Association Standards of Medical Care, 2003).

Classification of the Disease

The first widely accepted categorization for diabetes mellitus was provided by the National Diabetes Data Group (NDDG) in 1979. As a broad classification of disorders related to hyperglycemia, 5 forms of diabetes were recognized; insulin-dependent diabetes mellitus (IDDM, Type 1 diabetes), non-insulin-dependent diabetes mellitus (NIDDM, Type 2 diabetes), gestational diabetes mellitus (GDM), malnutrition-related diabetes and all other types. IDDM and NIDDM were recognized as the 2 major forms of this disease.
The ADA commissioned a study in 1995 to review advances in the understanding of this disease. The major outcome of this work is the movement away from classification based on type of pharmacological treatment (e.g. insulin-dependent vs. non-insulin-dependent) to a system based on the cause and origin of the disease (Gavin, 2003). Today, the terms insulin-dependent (IDDM) and non-insulin dependent diabetes mellitus (NIDDM) have been replaced with the terms Type 1 and Type 2 diabetes. The term for gestational diabetes, GDM has been retained. The classification of malnutrition-related diabetes has been dropped.

Type 1 diabetes is now defined as an illness characterized by the inability of the pancreas to produce insulin. This accounts for an estimated 5-10% of all diabetics with patients generally presenting with acute symptoms. Type 2 diabetes is defined as the illness which results from insulin resistance and/or a diminished capacity to produce this hormone and accounts for more than 90% of all diagnosed cases (Kenny, 2002). It should be noted that Type 2 diabetes is frequently undiagnosed until complications occur (American Diabetes Association Standards of Medical Care for Patients with Diabetes Mellitus, 2003).

This empirical study focuses on management of Type 2 diabetes for a number of reasons. This disease affects a large number of people and is very costly. Both the prevalence and costs related to this disease are increasing. The loss of life and suffering from complications of this disease are devastating. Finally, while a large percentage of diabetic patients suffer from Type 2 diabetes, many are not aware they have this disease until complications occur. More than 5 million American are estimated to have this disease but are not yet diagnosed (Centers for Disease Control and Prevention, 2003).
**Management of the Disease**

Management of Type 2 diabetes is complex and requires a number of interventions to improve outcomes. Continuing medical care and patient self-management education are necessary to reduce the risk of both acute events and long-term complications (American Diabetes Association Standards of Medical Care for Patients with Diabetes Mellitus, 2003). In a recent study of managed care members, the annual costs of providing care were 2.4 times greater for diabetic members than for a non-diabetic group with the same demographic characteristics (Selby, 1997). More than 40% of the costs in treating diabetic patients were attributed to complications of the disease (Selby, 1997). Further, another study has demonstrated the majority of hospitalizations for diabetic patients occur for co-morbid diseases, not for acute treatment of this disease (Roman, 2001). Disease management programs that focus on reducing the complications of this disease should result in decreased complications, mortality, costs savings and reductions in hospital inpatient acute care.

In a landmark clinical trial, the United Kingdom Prospective Diabetes Study demonstrated a significant reduction in the risk of developing micro vascular complications by managing blood glucose (UKPDS 33 Turner, 1998). However, management of this disease must extend beyond glycemic control and consider macro vascular complications as well. A majority of Type 2 diabetic patients die from cardiovascular disease (Nathan, 2002). While hyperglycemia increases the risk of cardiovascular disease (CVD), glycemic control does not substantially reduce CVD risk (Meigs, 2003).

While clinical evidence supports the delivery of preventive intervention services, a large gap exists between the care that should be delivered and the care that is actually delivered. A recent study of over two thousand adult diabetic patients found less than two percent received all
preventive services as defined by ADA standards (Beckles, 1998). Wisdom found less than twenty percent of more than two thousand HMO members received the recommended number of ADA laboratory tests for A1C and lipids (Wisdom, 1997). As the prevalence of this disease increases and the rate of compliance to such care standards remains low, increases in diabetic complications, utilization, and costs are inevitable (Gagliardino, 2000). This study attempts to guide disease management efforts by understanding how preventive screening services impact cost, utilization and outcomes for patients with Type 2 diabetes.

Statement of the Problem

The problem to be examined in this study is: what preventive screening services or combinations thereof reduce cost, utilization and improve health outcomes for patients with Type 2 diabetes?

Research Purpose

Understanding the effectiveness of preventive screening services is critical to managing disease outcomes and to effectively deploy limited disease management resources within the healthcare system. The central hypothesis of this study is preventive screening services improve outcomes for patients with Type 2 diabetes. This study includes three sub hypotheses to this central hypothesis:

\( H_1: \) Health-screening services in the base year are associated with lower follow-up period costs for patients with Type 2 diabetes.

\( H_2: \) Health-screening services in the base year are associated with lower follow-up period inpatient utilization for patients with Type 2 diabetes.

\( H_3: \) Health-screening services in the base year improve health outcomes by delaying the onset of co-morbid disease for patients with Type 2 diabetes.
Study Objectives

This study includes a comprehensive review of the literature, solicitation of domain expertise, and data analysis to produce original empirical findings:

- Identify preventive screening services that contribute to management of this disease,
- Identify confounding factors that influence cost, utilization and health outcomes,
- Identify study outcomes related to cost, utilization and health outcomes and document the influence preventive screening services have on these outcomes.

The empirical evidence from this study can be used to improve disease management efforts in the control of Type 2 diabetes. By understanding the preventive screening services or the combination of preventing screening services that are most effective, disease management efforts can focus on providing such services and ultimately improve health outcomes. Effective disease management will therefore result in reductions in cost and inpatient utilization for patients with Type 2 diabetes. Findings from this research can provide the basis for policy implications related to financial risk, benefit structures and best practice guidelines.
CHAPTER TWO - RELATED LITERATURE

The key findings of this literature review include empirical evidence to support reductions in microvascular complications from glycemic monitoring and control. Studies show glycemic control increases life expectancy as well as the quality of life for patients with this disease. Type 2 diabetes requires monitoring and interventions beyond glycemic control. Patients with Type 2 diabetes have a significant increased risk of cardiovascular disease and cardiovascular death. This increased risk establishes cardiovascular disease risk reduction as a primary focus of caring for patients with this disease. While evidence supports the need for preventive screening services studies show many patients with Type 2 diabetes receive suboptimal care.

This chapter includes three sections. The first section reviews literature related to preventive screening services. The second section reviews studies related to disease management studies and the third section of this chapter provides study justification.

A1C Lab Screenings

The American Association for Clinical Chemistry defines the ‘A1C Test’ as the test used to monitor a person’s diabetes. A blood sample is drawn from a vein in the arm or from a finger stick. This test measures what percentage of hemoglobin (red blood cells that carry oxygen and glucose) carries glucose molecules. By measuring A1C the average amount of glucose in your blood over the last several months can be recorded. A person without diabetes will have an A1C value between 4% and 6%. If you are diabetic, the closer you are to 6% the better your diabetes is under control (American Association for Clinical Chemistry, 2002). The ADA recommends testing A1C four times a year for patients not meeting treatment goals, and two times a year for
patient with stable glycemic control (American Diabetes Association Standards of Medical Care, 2003).

Intensive control of blood sugar substantially decreases the risk of micro vascular complications in patients with Type 2 diabetes (UKPDS 33 Turner, 1998). The United Kingdom Prospective Diabetes Study (UKPDS) tested the hypothesis that intensive blood-glucose control reduced the risk of micro or macro vascular complications in patients with this disease. Between 1977 and 1991, twenty-three UK hospitals referred over seven thousand newly diagnosed diabetes patients aged 25-65 to this study.

5102 patients were recruited from referrals to this study. Exclusions were reported to be similar in age, sex and glycemic status as those included in the study. Patients were excluded for a variety of reasons including pre-existing cardiac co-morbidities as well as patients with retinopathy requiring laser treatment. New patients to this study were seen monthly by a physician and a dietician for a three month period. Patients were advised to follow diets high in fiber, low in saturated fat and high in carbohydrates. After this introductory three month period fasting plasma glucose (FPG) was taken three times over two weeks and a mean FPG was recorded.

Patients were stratified by ideal bodyweight and those not overweight were randomly assigned to three groups based on treatment. Thirty percent of patients were assigned to a group to be treated with insulin, forty percent assigned to a group to be treated with sulphonylurea (an oral hypoglycemic) agents, and thirty percent assigned to a conventional group to be treated with diet. Overweight patients were assigned to four treatment groups. Twenty-four percent of patients were assigned to a group to be treated with insulin, thirty-two percent assigned to a group to be treated with sulphonylurea agents, twenty percent were assigned to a group to be
treated with metformin (a medication used for those intolerant to other hypoglycemics), and twenty-four percent assigned to a conventional group to be treated with diet. Once the patients were randomly placed in these seven groups the trial was open, meaning patients and clinicians were aware of the groups to which patients were assigned. No placebo treatments were included in this study.

This study finds intensive blood glucose control policy reduced average A1C values by eleven percent over ten years. Patients in the intensive treatment groups averaged an A1C value of 7.0% while patients in the conventional diet groups averaged and A1C values of 7.9%. More importantly, patients in the intensive treatment groups had decreased frequency of some clinical complications of Type 2 diabetes. The intensive treatment groups had a twenty-five percent reduction in the risk of micro vascular complications. No differences in the risk reduction of micro vascular complications were observed between the three intensive treatments (insulin, sulphonylurea or metformin). Improved glycemic control rather than one single therapy was considered the principal factor in reducing the risk for micro vascular complications.

This study did not find evidence that macro vascular disease or diabetes-related mortality differed between intensive and conventional treatments groups. There was no difference in the proportion of patients who had myocardial infarction or other cardiac events, as well as other evidence of peripheral vascular disease between the intensive and conventional treatment groups. Further, no differences in such rates were observed for the different therapies within the intensive treatment regimens. The authors of this study speculate that despite the duration of this study, even longer term studies may be required to measure differences in mortality rates and rates of cardiac morbidity.
A prospective randomized controlled clinical trial is currently underway to determine whether a reduction in major cardiovascular events can be observed between an intensive glycemic control group and a standard care group (Abraira, 2003). Veterans of at least 41 years of age who are non-responsive to oral agents or insulin injections are currently being screened for this study. Non-responsive is defined as having high A1C values (above 7.5%). The only planned difference between these 2 groups is the level of glycemic control. All other therapies including blood pressure and lipid control, use of aspirin, education, diet and exercise are intended to be identical in both groups. The trial is currently underway with a 2 year accrual period for patients and a planned 5 year follow-up. A total of 1700 patients from 20 participating VA Medical Centers are being enrolled in this study.

Long term prospective studies are costly, take many years and are logistically difficult. Some researchers have used computer simulations to study the impact of A1C values on a hypothetical cohort of patients. In a study completed in 2000, a Markov model incorporating numerous epidemiological studies estimated the clinical events and medical costs for persons with Type 2 diabetes across several maintained A1C values. Maintaining long-term glycemic control reduces complication rates and costs of medical care for patients with Type 2 diabetes (deLissovoy, 2000).

Simulated cohorts of patients were tracked over time through a series of health states that characterize the course of this disease. Tables of probabilities define the sequence of feasible transitions between health states and the length of time within that health state. This study modeled the most common complications affecting people with diabetes; cardiovascular disease, retinopathy, nephropathy, and neuropathy. In this model progression to a more severe health state within an organ system is independent of other organ systems. This means many
combinations of states across these organ systems can occur. Based on evidence described from UKPDS, this model assumed no effect of glycemic control on cardiovascular disease.

In this study, regardless of race or ethnic group and regardless of age at diabetes diagnosis, persons with lower maintained A1C values had fewer complications and lower direct medical costs. As maintained A1C values increased, so did the rate of complications for retinopathy and eventual blindness, microalbuminuria and eventual end stage renal disease, neuropathy and eventual lower extremity amputation. Maintained A1C values affected projected lifetime costs as well. This study suggests the costs of treating major complications of diabetes will increase substantially for younger patients with poor glycemic control who will experience complications at younger ages.

Another simulated cohort study in 2002 found the incremental cost-effectiveness ratio for intensive glycemic control to be $41,384 per quality adjusted life year (QALY) for Type 2 diabetes (Hoerger, 2002). Cost effectiveness analysis is a full economic evaluation where both costs and consequences of the treatment regimen are considered (Drummond, 2001). A Markov model was also used in this study. Costs were measured from the perspective of the healthcare system and outcomes were measured in QALYs. This study placed greater emphasis on macrovascular complications.

In this study a series of patient cohorts progressed through the model. Cohorts were defined by age, sex, race, hypertension status, hypercholesterolemia status and current smoking status. Similar to the 2000 study by deLissovoy, patient progressed simultaneously through different disease paths for coronary heart disease, retinopathy, nephropathy and neuropathy. Different from the 2000 study is the addition of the disease state for stroke.
In this model intensive glycemic control increases both life expectancy and QALY. The quality-adjusted life years for conventional glycemic control were 11.88 years. The quality-adjusted life years for intensive glycemic control were 12.07 years, or an increase of 0.1915 QALYs. Because patients lived longer with intensive glycemic control the standard treatment costs increase slightly. However, the cost of complications under intensive glycemic control drops by twelve percent. Total costs lifetime (standard treatment plus complications plus interventions) for intensive glycemic control is estimated to be $7,927 higher than conventional glycemic control. These incremental costs ($7,927) divided by the incremental increase in QALY (0.1915) lead to an incremental cost effectiveness ratio of $41,834 for each quality adjusted life year.

While this study shows the total costs for a cohort of simulated patients for intensive glycemic control increases, the cost of complications decrease. The direct effect of intensive glycemic control is the reduced incidence of nephropathy, neuropathy and retinopathy complications. Consistent with modeling using UKPDS data, no decreases in the incidence of coronary heart disease or stroke were observed in this model for intensive glycemic control.

While ADA recommends regular A1C testing for patients with Type 2 diabetes, most patients fail to have this monitoring procedure completed in accordance with these guidelines (Wisdom, 1997). A study in 1997 was designed to test the hypothesis that African Americans with diabetes had fewer tests to control their diabetes than their Caucasian counterparts. This study was conducted in an HMO setting to control for potential barriers to care such as poverty, lack of health insurance and access to health care.

This cohort study included individuals from a large, urban Midwest HMO continuously enrolled in 1991. 2312 adult members (18+) with at least one outpatient visit related to diabetes
ICD9-CM 250.0 through 250.9) were included in the study. Laboratory results were abstracted for glycosylated hemoglobin (A1C), creatinine (kidney function) and total cholesterol. Multiple tests in a quarter were counted only once. Insulin use status was obtained according to prescriptions filled for insulin for each patient. At the time of this study, the ADA recommended A1C be tested quarterly in insulin users and semiannually in insulin nonusers.

Insulin nonusers were more likely to receive the ADA recommended number of tests than insulin users. Regardless of race, less than nine percent of insulin users had quarterly A1C tests. Less than twenty-nine percent of insulin nonusers had semi-annual A1C tests. More striking, more than forty percent of insulin users and more than thirty percent of insulin nonusers did not have a single A1C test during the year of this study. The authors of this study draw the conclusion that a strong need to improve monitoring and disease control exists. The practice of suboptimal routine preventive care will continue to predispose these patients to further adverse health outcomes.

The Behavior Risk Factors Surveillance System (BRFSS) found similarly low compliance rates for testing A1C in 1995 (Saaddine, 2002). This federally funded project is a nationally representative population survey conducted by telephone. 3059 of the adult participants (aged 18-75 years of age) in this survey indicated they were diabetic, based on a physician diagnosis. Just 28.8% of diabetic participants in this survey indicated they had received at least A1C test in the previous year.

The importance of regular A1C checks may be diminished if patients have achieved adequate glycemic control. A 1999 study evaluated glycemic control in a representative sample of U.S. adults with Type 2 diabetes and found the level of glycemic control to be unacceptable (Harris, 1999). The Third National Health and Nutrition Examination Survey (NHANES III)
tested patients whose medical history included a physician diagnosis of Type 2 diabetes. Both fasting plasma glucose (FPG) and A1C values were measured in this survey completed between 1988 and 1994. 18,822 people over the age of 20 completed a household interview with 1,480 subjects considered to have Type 2 diabetes. A1C values were obtained for 1,253 of these diabetic subjects as well as 6,566 adults without diagnosed diabetes.

The mean A1C for all adults with Type 2 diabetes was 7.6%. This was significantly higher than the value of 5.2% (p< 0.01) for those without the disease. A large proportion of patients with this disease had unacceptable levels of A1C values. Just 44.6% of diabetic patients had A1C values less than seven percent; the level ADA considers being the goal for diabetic patients. More than 37% of Type 2 diabetic patients had A1C values greater than 8%; the level at which ADA recommends intensive therapy to control blood sugar. The authors of this study cite the dire need to identify high risk individuals and focus on achieving better glycemic control.

A more recent study fails to show progress in this area. A preliminary report on glycemic control among U.S. adults diagnosed with Type 2 diabetes show a marked decrease in glycemic control rates (Koro, 2004). This study relies on data from the 1999-2000 National Health and Nutrition Examination Survey (NHANES) recently released. 533 subjects aged twenty or more who indicated they had diabetes and in whom A1C had been measured were included in this analysis. After exclusions for Type 1 diabetes and missing attributes, 372 subjects were analyzed.

Not only has the prevalence of this disease increased, but the percentage of males and younger persons with Type 2 diabetes has increased relative to the NHANES III study. While just over 44% of the diabetic population had A1C values under 7% in the 1988-1994 study, just 35.8% of the 1999-2000 subjects met this same threshold for glycemic control. The authors of
this study conclude the proportion of U.S. adults with Type 2 diabetes under glycemic control is not only inadequate but less favorable than in previous years.

In summary, A1C screening is the test used to monitor and control Type 2 diabetes. Intensive glycemic control reduces the values of A1C as well as micro vascular complications related to this disease. The evidence related to macro vascular complications and diabetes related morbidity is inconclusive. Maintaining long-term glycemic control not only reduces complication rates but the costs of medical care for these patients. However, very few patients follow recommended guidelines for monitoring A1C values and controlling their levels of blood glucose. Those patients with stable glycemic control should complete this prevention screening twice per year. Patients without stable glycemic control should complete this prevention screening four times per year. Not only are the rates of glycemic control among Type 2 diabetic patients low, but the rates of patients under glycemic control are decreasing.
Eye Exam Screenings

A common complication of diabetes is diabetic retinopathy. This disease causes breaks, leaks or blockage of the tiny blood vessels of the retina. In the less severe type of the disease the existing blood vessels leak fluid into the retinal. This condition is called Background Diabetic Retinopathy (BDR). In the more advanced stages of the disease new vessels grow in the eye. These new blood vessels are fragile and can hemorrhage, leading to loss of vision and scarring. This condition is called Proliferative Diabetic Retinopathy (PDR) (Medline, 2004).

Diabetic retinopathy is the most frequent cause of new cases of adult blindness (Fong, 2004). The first studies to document the relationship between glycemic control and the initial appearance and subsequent progression of diabetic retinopathy, involved patients with Insulin Dependent Diabetes Mellitus (IDDM) or by today’s terminology, Type 1 diabetes. The Diabetes Control and Complications Trail (DCCT) started in 1986, followed patients an average of 6.5 years (The Diabetes Control and Complications Trial Research Group, 1993). 1141 patients with IDDM included 726 patients without retinopathy at baseline and 715 with mild retinopathy. These patients were randomly assigned to intensive therapy group including frequent blood glucose monitoring and 3 or more daily injections of insulin. The conventional treatment group included 1 or 2 daily injections of insulin.

For patients who entered the DCCT without retinopathy intensive glucose therapy reduced the risk for the development of retinopathy by 76% compared to conventional therapy. Patients with mild retinopathy experienced slower progressions of retinopathy by 54% in the intensive therapy group compared to the conventional therapy group.

Studies such as the Diabetes Control and Complications Trial (DCCT) demonstrated the impact of hyperglycemia and the incidence of diabetic retinopathy in Type 1 diabetics. A number
of recent studies confirm the benefits of glycemic control for patients with Type 2 diabetes for micro vascular complications such as diabetic retinopathy.

The UKPDS began in 1977 in the UK to investigate the risk of both macro vascular and micro vascular complications in Type 2 diabetic patients (UKPDS 33 Turner, 1998). By 1991 over five thousand patients aged 25-64 with newly diagnosed diabetes were participating in this research. After a three month period in which patients received monthly clinic-based instruction on diet, treatment was started. Patients were randomized to 2 different groups; a conventional treatment and an intensive treatment group. The conventional treatment group received regular dietary advice with the goal of maintaining near-normal bodyweight. If a patient in the conventional therapy group experienced high levels of glycemia or developed other complications, they received drug therapy. Patients in the intensive treatment group also received dietary advice but were treated with drug therapy to maintain lower levels of blood sugars.

As discussed earlier, this trial found that an intensive blood-glucose-control policy reduced median A1C values by 11%. The intensive treatment group had a 25% reduction in the risk of micro vascular endpoints. Most of the reduction in the rates of these clinical endpoints was related to fewer patients requiring photocoagulation (lasers used to repair retinal damage). While rates of progression of diabetic retinopathy were similar within the first 3 years of participation in the study (15.8% in the intensive treatment group versus 15.3% in the conventional treatment group), rates were significantly different as time passed. After 12 years in the study nearly half (48.6%) the patients in the conventional treatment group experienced significant progression in diabetic retinopathy. Only 38.6% of the intensive treatment group experienced similar progression.
While this study lasted for a lengthy period of time, study authors suggest more time would be needed to see higher rates of vitreous hemorrhage or blindness. Few patients in this study experienced these late ophthalmic complications. Finally, while this study explored three different intensive treatment regimens, no significant difference were observed in micro vascular rates of complications between these three groups. Improved glycemic control, not one particular treatment regimen explained reductions in risk.

Loss of vision was much more pronounced among diabetic patients in the Wisconsin Epidemiologic Study of Diabetic Retinopathy (Klein, 1995). This study randomly selected 1210 Type 1 diabetics and 1780 Type 2 diabetics from southern Wisconsin who received primary care for diabetes in 1979 and 1980. Of the Type 2 diabetic patients selected, 1,370 participated in the baseline examination, 987 took part in the 4 year follow-up and 533 patients completed the 10 year follow-up. The primary reason for not participating in the 10 year follow up was death.

Baseline and follow-up examinations were completed in a mobile examination van near participant’s home city. Eye exams, blood pressures, lab exams for urine and blood, and a physical examination were conducted during each visit.

The 10 year incidence of any retinopathy was 79.2% for Type 2 diabetic patients taking insulin and 66.9% for Type 2 diabetic patients not taking insulin. A1C baseline levels were found to be a significant predictor of retinopathy in both Type 1 and Type 2 diabetic patients. Further, progression of A1C values coincided with increasing incidence of retinopathy and progression of retinopathy to more severe states. This statistically significant relationship held true even after controlling for duration of diabetes, severity level of retinopathy at baseline, age and sex. 32.8% of Type 2 diabetic patients taking insulin and 21.4% of patients with Type 2 diabetes not taking insulin experienced loss of vision over the 10 years of the WESDR study.
Once researchers established the link between improved glycemic control and reduction in diabetic retinopathy, preventive screening services such as dilated retinal eye exams effectiveness were questioned. However, even with increased glycemic control, evidence has shown the risk of blindness from diabetic retinopathy has not changed despite increased glycemic control (Brown, 2003). 6,993 Type 2 diabetic patients continuously enrolled in an HMO in 1997 and 1998 with at least one dilated retinal examination during this time period were included in this study. Retinal status was based on classification as Background Diabetic Retinopathy (BDR), Proliferative Diabetic Retinopathy (PDR) and Macular Edema (ME), based on diagnosis.

Similar to results recorded in the UKPDS and WESDR studies, the prevalence of retinal disease increases with age and duration of diabetes in this study. Based on such evidence, this group of patients had much better glycemic and hypertension control compared to patients in the WESDR study. Accordingly, prevalence rates for BDR are much lower than those observed in the WESDR study. However, the prevalence rates for PDR are not significantly different from PDR rates found in the WESDR study. This large population-based study suggests glucose control as well as hypertension control has decreased the incidence of background diabetic retinopathy, but the prevalence of PDR remains elevated. PDR as the more severe form of this disease puts loss of vision at a much greater risk.

Diabetic retinopathy has few visual or ophthalmic symptoms until visual loss develops. It is important to identify and treat patients early with this disease. Therefore, patients with diabetes should be routinely examined to detect diabetic retinopathy (Fong, 2004). Based on ADA standards of care, patients with Type 2 diabetes should have an initial dilated and comprehensive
eye exam shortly after diagnosis of the disease. Repeat examination should be conducted on an annual basis (American Diabetes Association Standards of Medical Care, 2003).

Despite the risk of blindness, more than one-third of diabetic patients have not had an eye examination in the previous year (Saaddine, 2002). Even after adjusting for those with medical insurance, just 66.5% of diabetics completed this preventive screening in the previous year. To assess compliance to ADA guidelines for care of diabetic patients, this study used the Behavioral Risk Factor Surveillance System (BRFSS). 3059 patients with diabetes participated in this phone survey in 1995. Adults 18-75 years of age were included in this study.

In summary, diabetic retinopathy is a common micro vascular complication of Type 2 diabetes that can lead to blindness. Several clinical studies have demonstrated reductions in risk associated with better glycemic control. However, data from the most recent study suggests that even under improved levels of glycemic control, the risk for the more severe form of this disease (PDR) does not decrease. The preventive screening service to monitor and control diabetic retinopathy is an annual dilated retinal exam. Similar to other preventive services described in this report, despite the evidence and risk of complications, many patients with Type 2 diabetes do not have this exam completed on a regular basis.
Lipid Lab Screenings

Cardiovascular disease is the major cause of death in patients with Type 2 diabetes (Morrish, 2001). This study focused on 4713 participants in the World Health Organization (WHO) Multinational Study of Vascular Disease in Diabetes. Death certificates and autopsy reports from ten locations around the world were reviewed to determine the causes of death for 1099 of these subjects. Cardiovascular diseases (ICD9-CM codes 390-459, 798.1) were the most common cause of death in 52% of patients with Type 2 diabetes. By comparison, less than 3% of study participants died from causes directly attributed to diabetes (ICD9-CM codes 250, except 250.3).

Empirical evidence from two major prospective trials has confirmed the equivalence of diabetes and a previous acute myocardial infarction (AMI) as risk factors for mortality among patients following an AMI (Mukamal, 2001 and Haffner, 1998).

In the U.S. prospective cohort study, 1935 patients hospitalized for AMI were followed for 5 years ending in 1993 (Mukamal, 2001). Patients enrolled in the Determinants of Myocardial Infarction Onset Study had their medical charts reviewed and were personally interviewed.

During the follow up period in this study, 29% of the diabetic patients died, compared to 13% of non-diabetic patients. The survival rates for patients with a prior MI were statistically identical to the survival rates for patients with diabetes. Either diabetes or a previous AMI were associated with a nearly twofold increase in long-term mortality after myocardial infarction.

With such a marked increased risk of coronary heart disease in patients with Type 2 diabetes, researchers have addressed whether patients with diabetes who have not yet exhibited cardiovascular events such as myocardial infarctions (MI) should be treated as aggressively as
patients who have already had such an event. This research has shown cardiovascular risk factors in diabetic patients should be treated as aggressively as non-diabetic patients with a prior MI.

In the Finnish study, patients 45-64 years of age were selected based on their use of drugs for diabetes (Haffner, 1998). 1059 patients with Type 2 diabetes took part in the baseline study from 1982 to 1984. A random control sample of 1373 subjects born and living in the same geographic region as the diabetic group was selected based on the same age group, 45-64 years of age.

The baseline examination included a review of medical records, blood collection, blood pressure measurements and interviews were conducted on both the diabetic and the control group. The patient interview conducted during the outpatient visit included smoking, alcohol use, physician activity, the use of drugs, and any history of chest pain suggestive of coronary heart disease (CHD). Hypertension was classified as a dichotomous variable if the patient was receiving drug treatment for hypertension or their blood pressure measurement systolic exceeded 160 mm Hg or a diastolic pressure exceeded 95 mm Hg. Blood collections occurred at 8:00 a.m. after a 12 hour fast.

The follow-up portion to this study occurred in 1990 when a questionnaire about hospitalization for cardiovascular events was sent to every surviving subject. Medical records and autopsy records were reviewed for patients who died during the years between baseline and 1990. Medical records were also reviewed for patients who indicated they did not have a cardiovascular related hospitalization.

As the researchers of this study suspected, diabetic subjects had much higher mortality from coronary heart disease compared with the non-diabetic subjects. After seven years the incidence of cardiovascular events for patients without a prior myocardial infarction (MI) was
3.5% for the non-diabetic subjects. For diabetic patients without a prior MI the rate was significantly higher (p < 0.001) at 20.2%. Similar statistically significant rates between these two groups were observed for stroke and death from cardiovascular causes.

The more critical issue within this study is the comparison between diabetic subjects without a prior MI and non-diabetic patients with a prior MI. Diabetic subjects without a prior MI had incidence rates at 20.2%, very similar to the 18.8% incidence rate recorded for non-diabetic patients with a prior MI. Similar rates for these two groups are observed even after adjusting for demographic variables (age and sex) and other cardiovascular risk factors (smoking, hypertension, LDL cholesterol levels, HDL cholesterol levels and triglyceride levels). The authors concluded a similar base-line risk of cardiovascular disease exists for diabetic patients as those with prior cardiac events and that similar management of cardiovascular risk factors is indicated.

This status of diabetes as a CHD risk equivalent has focused cardiovascular disease risk reduction as a primary target for patients with Type 2 diabetes (Meigs, 2003). Based on this emphasis to reduce cardiovascular risk factors, clinicians are directed to watch for signs and symptoms of macro vascular complications (American Diabetes Association Standards of Medical Care, 2003). Dyslipidemia, a condition marked by abnormal concentrations of lipids or lipoproteins in the blood, is another common co-existing condition among patients with Type 2 diabetes and a major risk factor for macro vascular disease. Lipid management aims at lowering LDL cholesterol, raising HDL cholesterol and lowering triglycerides (American Diabetes Association Standards of Medical Care, 2003).

Several clinical studies have demonstrated reduced cardiovascular risks associated with lipid management in the general population. In a double-blind randomized trial titled the Long-
Term Intervention with Pravastatin in Ischemic Disease (LIPID), patients with a history of unstable angina or prior myocardial infarction received pravastatin (a drug that inhibits the production of cholesterol) or a matching placebo (Glasziou, 2002). All cause mortality and cardiovascular disease mortality were evaluated among these two randomized groups.

This trial included 9014 patients aged 31-75 years throughout New Zealand and Australia. Patients with unstable angina or those who had acute myocardial infarction and moderate levels of cholesterol were selected for this study. Patients received dietary advice and either pravastatin or a placebo daily. The recruitment period occurred in 1990-1992 with a scheduled follow-up five years later. Baseline characteristics were reported to be well balanced between the control and intervention groups.

All cause mortality differed between the pravastatin (treatment) and placebo (control) groups. After an average of 6 years 14.1% of the placebo group died. Those patients in the pravastatin group experienced an 11.0% mortality rate. This 23% reduction in mortality is statistically significant (p < 0.001). Further, no differences in rates were recorded in non-cardiovascular diseases, just death from cardiovascular diseases and stroke. While a risk reduction was observed in patients with diabetes in this trial, this result was not statistically significant.

A subgroup analysis of the Cholesterol and Recurrent Events (CARE) Trial has shown diabetic patients risk for recurrent cardiovascular events can be substantially reduced by pravastatin treatment (Goldberg, 1998). The CARE double-blind trial lasted five years in which 4159 patients aged 21-75 with previous myocardial infarction and normal lipid levels received pravastatin or a placebo. While this research was designed to examine the general population, this trial included a relatively large cohort of diabetic patients. This analysis included
comparisons of a diabetic segment (n=586) to a non-diabetic group (n=3573). 304 patients were included in the study who were classified as diabetic and who received a placebo, while 282 patients classified as diabetic received the cholesterol lowering treatment. Measured outcomes included a fatal coronary event or a nonfatal myocardial infarction.

Consistent with other studies discussed in this report, compared to non-diabetic patients, diabetic patients experienced nearly twice the number of CHD deaths, myocardial infarction, CABG, stroke and unstable angina events. However, diabetic patients in the lipid treatment group experienced reductions in LDL, triglycerides and cholesterol and an increase in HDL at levels similar to patients without diabetes. Most importantly, pravastatin treatment in patients with diabetes resulted in a 25% reduction or risk from cardiovascular events. This risk reduction is comparable to mortality reduction in patients without diabetes. However, because of the higher cardiovascular event rates in the diabetic group, a greater absolute reduction in cardiovascular events was observed in this study for patients with diabetes compared to those without diabetes.

The Heart Protection Study Collaborative Group is the largest clinical study to date that has examined the benefits of lowering cholesterol for diabetic patients (Heart Protection Study Collaborative Group, 2003). Nearly six thousand patients with diabetes and an additional 14,573 patients without diabetes but with high risk for cardiovascular disease were included in this study in the UK. Adult patients (aged 40-80 years) were randomly allocated to receive simvastatin or a placebo. Patients were enrolled in this study between the years of 1994 and 1997. Participants were seen regular in the study clinics for routine follow-up checks with blood samples taken at each visit. A follow-up was scheduled for all participants between August 2000 and February 2001 after an average of 4-6 years in the study. Diabetic patients in this study presented baseline
lipid levels slightly better than levels recorded in the non-diabetic patients at high risk for cardiovascular disease.

Both diabetic patients and non-diabetic patients under lipid control in this study experienced a 27% reduction in the incidence of first non-fatal myocardial infarction or coronary death. Cardiac mortality was reduced 20% among diabetic patients in the simvastatin group. Diabetic patients also experienced a 37% reduction in first non-fatal myocardial infarction. Further, this study has shown cholesterol lowering statin therapy is beneficial, regardless of the degree of glycemic control and even initial cholesterol concentrations. Study authors conclude these results support a renewed emphasis on the control of macro vascular risk factors beyond glycemic control, in people with diabetes.

The ADA recommends screening for lipid management at least annually. Compliance rates for this prevention screening service are relatively high compared to the previously discussed rates for glycemic control. 72% of diabetic patients had their cholesterol levels checked in the previous year (Wisdom, 1997). The authors of this study of HMO patients speculate better compliance is associated with the lesser frequency of intervention required to achieve this clinical standard of care.

The Behavioral Risk Factors Surveillance System (BRFSS) reports similar results for compliance for this prevention screening service (Saadine, 2002). This federally funded telephone survey in 1995 included adult patients who reported receiving a previous diagnosis of diabetes from a physician. The survey included 109,929 respondents; 3059 of whom reported as having diabetes. Biannual lipid testing was reported in 85.3% of diabetic participants.

However, higher compliance for screening abnormal lipid levels does not necessarily imply that patients with diabetes have their lipid levels under control. Many diabetics in the U.S.
have elevated cholesterol levels (Saadine, 2002). This study used data from the federally funded, National Health and Nutrition Examination Survey (NHANES III) to determine the distribution of LDL cholesterol values. This survey included an interview and within 4 weeks, a follow-up clinical examination. This study included 16,705 participants, 1026 of who reported receiving a diabetic diagnosis from a physician. Despite high rates for screening for lipid management, just 11% of patients in this study had LDL cholesterol levels below 100 mg/dl, the treatment goal for adults with Type 2 diabetes (American Diabetes Association Standards of Medical Care, 2003).

Finally, while lipid control has been shown to improve health outcomes, total costs for treating Type 2 diabetic are expected to increase (Hoerger, 2002). As described earlier, this study used a Markov model of Type 2 diabetes disease progression to calculate incremental cost-effectiveness ratios for interventions such as cholesterol control. Patient cohorts, newly diagnosed with diabetes are simulated through 5 different disease paths; nephropathy, neuropathy, retinopathy, CHD and stroke. Based on studies previously described, diabetic patients with CHD were simulated to receive pravastatin or no drug treatment.

Costs in this model are based on the perspective of the health care system. The cost of treatment with pravastatin was based on a daily dose and 4 office visits with blood test samples and lipid profiles in the first year, and 2 physician visits with tests thereafter. Complication costs are the cost of nephropathy, neuropathy, retinopathy, CHD, stroke and death.

In this model, reductions in cholesterol levels increased life expectancy by an average of 0.6722 years and a discounted QALY of 0.3475. Similar to previously described cost effectiveness analysis, standard treatment costs increase based on this longer expected life span. For similar reasons, diabetic patients living longer increase the costs of complications. Among the three interventions evaluated (intensive glycemic control, intensive hypertension control and
reducing cholesterol levels) this intervention costs the most. The incremental total cost of this intervention is over $18,000. Based on the increase in QALY, the cost-effectiveness ratio for this intervention was calculated to be $51,889 per QALY. By comparison, the incremental cost-effectiveness ratio for intensive glycemic control was $41,384 per QALY. On the other hand, intensive hypertension control both reduces costs and improves quality adjusted life years with a modeled incremental cost-effectiveness ratio of <$1959>.

To summarize, macro vascular disease is the leading cause of death among patients with Type 2 diabetes. The risk of macro vascular events is as high for Type 2 diabetic patients as the risks for patients with previous cardiovascular events. Empirical evidence has shown significant reductions in cardiovascular risk by patients with statin therapy to control concentrations of lipids in the blood. These findings have been replicated in the general population and for patients with diabetes mellitus. Diabetic patients without such control experience a two-fold increase in cardiac mortality and cardiovascular events. Diabetic patients should have their lipids checked at least annually. While many patients appear to be receiving this prevention screening service, few diabetic patients are reducing their lipid levels to normal. Finally, while cost effectiveness analysis demonstrates increases in quality life years to be gained by such interventions, it must be recognized this intervention screening service is costly.
**Albumin Lab Screenings**

Another serious microvascular complication of Type 2 diabetes is diabetic nephropathy. This disease is characterized by a loss of function in the kidneys. Kidneys act as a blood filter removing wastes and forming urine. Based on microvascular damage caused by diabetes mellitus the ability of these organs to function is diminished. One of the earliest markers of diabetic nephropathy is the presence of protein (albumin) in the urine. Albumin lab screening is another very important preventive screening service used to monitor and control microvascular complications related to this disease (MedlinePlus, 2004).

As discussed earlier, the first studies to document the effect of glycemic control on microvascular complications involved Type 1 diabetics (the term for this disease at the time of the research was Insulin Dependent Diabetes Mellitus (IDDM)). The most frequently cited study is the Diabetes Control and Complications Trail (DCCT) completed in the U.S. and Canada. This study found intensive insulin therapy delayed the onset and slowed the progression of diabetic retinopathy, diabetic neuropathy and diabetic nephropathy (The Diabetes Control and Complications Trial Research Group, 1993).

This randomized controlled clinical trail included a principal outcome of the initial appearance and subsequent progression of background retinopathy. However, this study included measures of protein in the urine of these patients. The two cohorts of patients in this study included those who entered the study without retinopathy and those who entered the study with retinopathy. In both these cohorts combined intensive insulin therapy reduced the occurrence of microalbuminuria by 39% as compared to the conventional treatment group. Microalbuminuria was defined as the excretion 40 mg to 300 mg of albumin in a 24 hour period. For the more advanced stages of diabetic nephropathy intensive insulin therapy reduced the occurrence of
albuminuria by 54% as compared to the conventional treatment group. Albuminuria is defined as the excretion of more than 300 mg of albumin in a 24 hour period. Study authors were able to conclude with empirical evidence the onset and progression of diabetic nephropathy could be delayed with intensive insulin therapy in Type 1 diabetics.

Maintaining near-normal levels of blood sugars during the DCCT period (1987-1993) have provided continued delays in the progression of diabetic nephropathy (Epidemiology of Diabetes Interventions, 2003). 1349 of the original DCCT study were examined at years 7 or 8 following the end of the study in 1993. New cases of microalbuminuria were reduced by 59% comparing the original intensive treatment to the conventional treatment groups. A 57% reduction in the more severe albuminuria was observed between the 2 groups as well.

A similar study was conducted in Japan shortly after the release of DCCT results. The Kumamoto study reports similar results that intensive insulin therapy delays the onset and progress on micro vascular complications but in Non Insulin Dependent Diabetes Mellitus (NIDDM) or by today’s terminology, Type 2 diabetic patients (Ohkubo, 1995). The major drawback to the validity of this study is the sample size. Just 110 Type 2 diabetic patients were included in this study. Patients recruited for this study were currently taking 1 or 2 insulin injections each day. Patients were split into 2 equally sized cohorts. The primary intervention group included patients without retinopathy and with urinary albumin excretions less than 30 mg in a 24 hour period. The secondary intervention group included patients with mild retinopathy and urinary albumin excretions less than 300 mg in a 24 hour period. These 110 patients were further assigned to a conventional insulin injection therapy group or a multiple insulin injection therapy group. The differences in treatment regimens were similar to DCCT. The conventional insulin injection therapy group continued to receive 1 or 2 daily injections of insulin. The
multiple insulin injection therapy group of patients received 3 or more injections per day at each meal. Dosage was adjusted according to self-monitored levels of blood glucose. After 6 years 3 patients had died and 3 patients left the study.

After 3 months and maintained for the 6 years of the study, near normal glycemic levels were achieved in patients in the multiple insulin injection therapy group. Glycemic control in the conventional insulin injection therapy group did not change significantly. More importantly, the development of nephropathy after 6 years was significantly lower in the multiple insulin injection therapy group. This conclusion was drawn on a very small number of patients who experienced progressions in diabetic nephropathy. 5 patients in the conventional group developed microalbuminuria. 2 patients in the multiple insulin injection therapy group developed microalbuminuria. While no patients developed albuminuria in the multiple insulin injection therapy group, 2 patients developed this disease in the conventional group.

Studies that did not include Type 2 diabetic patients or studies that were based on a small number of observations represented a significant gap in the literature until the results of UKPDS were published. Significant reductions in diabetic nephropathy (as well as other micro vascular complications) can be achieved through glycemic control in patients with Type 2 diabetes (UKPDS 33 Turner, 1998). This study, described earlier, recruited more than five thousand newly diagnosed Type 2 diabetics patients from 23 hospitals in the U.K. Patients were randomly placed into 2 groups; intensive therapy to control glycemic levels and a conventional group controlling glycemia by diet. Every year urinary albumin samples were taken.

Results for microalbuminuria at baseline were based on 2408 patients in the intensive group and 994 patients in the conventional group. 11.3% of the intensive group had microalbuminuria at baseline while 12.8% of the conventional group had this disease. 1260 total
patients were evaluated for microalbuminuria after 12 years in the study. While 23% of the intensive group now experienced microalbuminuria, 34.2% of the conventional group shows signs of this disease. Similar patterns were demonstrated with albuminuria after 15 years. 7.3% of the intensive therapy groups had albuminuria where 12.6% of the conventional group had this disease. All of these results were statistically significant (p < 0.05). The authors concluded that an intensive blood glucose control policy with the associated reduction in median A1C resulted in fewer micro vascular complications from Type 2 diabetes, such as nephropathy. Most importantly, the median complication free interval was 1-3 years longer in the intensive group compared to the conventional group.

Not all Type 2 diabetic patients share the same risk for the development of diabetic nephropathy (Gall, 1997). This prospective study sought to understand the risk factors associated with the development and progression of diabetic nephropathy. The study population included 176 patients under 66 years of age who attended a UK hospital in 1987. Patients with microalbuminuria or albuminuria at baseline were excluded. Subjects in this study were followed for 6 years with an average of 6 urine collections for each patient.

This study reports a rate of diabetic nephropathy after nearly 6 years at 23%. However, this is based on 36 patients developing microalbuminuria and 5 patients developing albuminuria. While the validity of this study based on small sample size can be questioned, the factors these patients shared help warrant future study design. In this small study the major determinants of diabetic nephropathy were minimal increases in albumin excretions within the normal range, poor long term glycemic control, increased concentrations of cholesterol, presence of retinopathy, older age and male. As discussed previously, modifiable risk factors such as glycemic control and lipid control have been shown to reduce complications for patients with Type 2 diabetes.
For patients with Type 2 diabetes, intensified multi-factorial interventions may slow the progression of diabetic nephropathy (Gaede, 1999). In a Danish study behavior changes and pharmacological therapy were tested for their effect on progression of the microvascular complications in Type 2 diabetic patients with microalbuminuria. Patients aged 40-65 were randomly assigned to standard treatment (n=80) or intensive treatment (n=80). Patients in the control treatment group followed established medical guidelines. Patients in the intensive group were treated by a project team that aimed to limit dietary intake to 30% or less calories from fat, light to moderate exercise for 30 minutes, 3-5 times per week and to be non-smokers. Patients received medication to control blood pressure, vitamins and aspirin (for patients with history of ischemic cardiovascular disease. If patients could not maintain A1C values a stepwise progression of medication was used. A similar pattern was followed with patients to control blood pressure. The primary microvascular endpoint for this study was albuminuria (urine proteins above 300 mg in a 24 hour period). Patients received clinical examinations every 3 months for years. The study finished at the end of 1997.

Similar to studies cited earlier, small sample sizes put in question the validity of the results of this study. However, design variables are worth noting. 8 patients in the intensely treated group developed nephropathy while 19 patients in the standard treatment group developed nephropathy. Similar reductions in retinopathy and neuropathy were observed between the intensive therapy and conventional therapy groups. Despite the lack of statistical power the authors of this study cite the need for multi-factorial interventions to slow the progression of microvascular complications for patients with Type 2 diabetes.

The ADA recommends optimizing both glucose control and blood pressure control to reduce the risk or slow the progression of diabetic nephropathy. Annual screening for albumin is
recommended for all patients with Type 2 diabetes (American Diabetes Association Standards of Medical Care, 2003).

While macro vascular complications related to Type 2 diabetes are the most expensive, the costs of nephropathy complications are the most expensive among the 3 major microvascular complications (Caro, 2002). A basis for performing economic analyses was provided in this Monte Carlo model in which Type 2 diabetic patients were simulated from diagnosis through death. Each hypothetical patient is assigned characteristics based on distributions of age, race, sex, cholesterol, smoking and systolic blood pressure. A1C levels for these hypothetical patients were set at 8.4%. Based on evidence from UKPDS, despite glycemic control, patients would receive an average of 0.15 percentage point increases per year. This model yields comparable results of UKPDS patients in terms of risk for all-cause mortality and risk of microvascular disease at 12 years.

On average patients in this model incurred costs related to managing complications that averaged $47,240 over 30 years. The management of macrovascular disease represents the largest cost component at 52% of these costs. Nephropathy accounted for 21% of the costs, neuropathy 17% of these costs and retinopathy accounted for 10% of lifetime costs related to complications. Consistent with several studies cited in this review, the key factor in development of complications and consequently cost, is the level of glycemic control achieved. It should be further noted that while macrovascular complications represent the largest cost component, these costs are incurred much earlier in the lifetime of the patient with Type 2 diabetes.

In summary, the strongest empirical evidence for diabetic nephropathy is the relationship between levels of glycemic control and reductions from the risks associated with the onset and progression of this disease. Continued surveillance of urine albumin levels provides an
assessment of both the progression of diabetic nephropathy as well as an ability to assess response to therapy in the areas of glycemic control. The costs of controlling complications related to diabetic nephropathy have been shown to only be surpassed by the costs of managing complications for macrovascular disease. ADA guidelines suggest annual screenings. Measures that document the quality of diabetes care in the U.S. do not include an assessment of the rate of compliance for this preventive screening.
Disease Management Studies

Disease management programs are one of the key tools that healthcare organizations have used in attempts to control costs and assure quality for patients with chronic disease (Pilnick, 2001). Increased outpatient services are provided to patients to improve control of this disease. Sidorov describes the benefits of an opt-in disease management program within a managed care environment (Sidorov, 2002). Lindstrom describes the benefits of intensive glycemic control associated with a large number of face-to-face consultations in the Finnish Diabetes Prevention Study (Lindstrom, 2003). Finally, UKPDS 34 describes the importance of ongoing efforts to control and manage Type 2 diabetes (Turner, 1998).

Within an HMO setting disease management programs may reduce inpatient admissions and total costs for diabetic patients (Sidorov, 2002). This study compared health care costs for patients in an HMO-sponsored disease management program with costs for those patients not in a disease management program. While the consequences of poor glycemic control occur over many years (e.g. 12-15 year rates of complications reported in UKPDS), this study sought to understand the impact of disease management programs on short-term costs for patients with diabetes mellitus.

Recruitment of patient for diabetes disease management began in 1997. Under the disease management program patients voluntarily opt in. Diabetic patients are given a glucose meter and 100 test strips at no cost. All patients are seen by a diabetic nurse 1-4 times throughout one year to receive education on use of the glucose meter, diet and exercise, the importance of A1C testing, and medication management. These diabetic nurse educators work closely with primary care physicians to achieve optimal blood glucose control. Data from 6,799 patients with diabetes were identified based on HEDIS criteria and used in this 2 year study. Chart review and medical
claim analysis was used to collect data without knowledge of disease management program status. Pharmacy claims were not included in this analysis. 3,118 patients had enrolled in disease management while 3,681 diabetic subjects were not enrolled in this disease management program.

During this 2 year study diabetes disease management program participants experienced per member per month (pmpm) costs of $394.62. The mean costs for diabetic patients not in the disease management program were $502.48 pmpm (p<0.05). Patients in the diabetic disease management program had fewer inpatient admissions per patient per year (pppy) averaging 0.12 admissions. Patients not in the disease management program experienced 0.16 admission pppy (p < 0.05). Further, mean number of emergency room visits was 0.49 pppy for disease management program patients and 0.56 pppy among patients not in the program (p < 0.05). Further, patients in the disease management program had higher numbers of primary care office visits at 8.4 pppy compared to non-program participants at 7.8 pppy (p < 0.05).

Beyond decreased utilization for inpatient and emergency care, and a shift to primary care office visits, program participants experienced better clinical outcomes in comparison to non-program participants. A1C screenings (96.6% to 83.8%), lipid screenings (91.1% to 77.6%), eye exams (79.1% to 64.9%) and albumin screening (68.5% to 39.3%) rates were all higher among program participants compared to those not in the program. Finally, 1074 charts were reviewed (roughly half from each group) to check for high A1C values. 6.7% of program patients had A1C values about 9.5% while 14.4% of those not in the disease management program had A1C values above this threshold.

These 2 cohorts were not the same, comprising the comparability of these results. Diabetic patients who voluntarily enrolled in the disease management program were on average,
1.4 years younger, had been enrolled in the HMO for a longer period of time, were more likely to have a pharmacy benefit package and were more likely to have commercial insurance. Without controlling for severity of illness between the program group and the non-program group, the cause of these cost, utilization and clinical outcomes are difficult to ascertain. However, this study identifies an important area for continued study.

Intensive lifestyle interventions that include an increase in face-to-face consultations improve outcomes for glucose intolerant patients (Lindstrom, 2003). 522 patients aged 40-64 who were overweight and demonstrated glucose intolerance, were enrolled in the Finnish Diabetes Prevention Study (DPS) between the years of 1993 and 1998. Patients were randomized into a control group and an intensive lifestyle intervention group. The control group received a baseline consultation on the importance of weight control, activity level and diet and annual examinations. The intensive lifestyle intervention group received the same information on diet, weight control and physical activity but in face-to-face consultations seven times in the first years of the study and quarterly thereafter. Supervised, individually tailored circuit training exercise programs were available free of charge. The study was prematurely terminated in 2000 with an observed incidence of diabetes significantly higher in the conventional group compared to the intensive lifestyle intervention group.

The intensive lifestyle intervention group experienced significantly better clinical measurements at year 1 through year 3 in comparison to the conventional group. Weight loss, fasting plasma glucose (FPG) levels, A1C, and cholesterol levels improved significantly in the intensive lifestyle intervention group over the conventional treatment group. During the first 3 years of the study 9% of the intervention group developed diabetes compared to 20% in the control group (p < 0.001). Finally, interventions were greater in number in the first year of
patients in this study, and consequently, changes in clinical measurements improved the greatest during this period.

The UKPDS found glycemic control in Type 2 diabetic patients, even those under intensive therapy, deteriorated over time (UKPDS 34, Turner, 1998). By 1990, researchers in the UKPDS Group found increasing levels of glycemia despite increases in sulfonylurea (oral hypoglycemic agents) drug therapy. UKPDS was modified to assign some overweight patients originally allocated to sulfonylurea therapy, to a treatment group that included the addition of metformin (another hypoglycemic medication used in patients unresponsive to sulfonylurea therapy). This research compared the 411 overweight patients assigned conventional therapy to 342 overweight patients assigned to intensive treatment with metformin. Patients were seen every month for the first 3 months and then every 3 months or even more frequently in the attempts to attain glycemic control.

Patients in the intensive treatment with metformin group had lower median A1C values of 7.4% compared to the conventional treatment group’s median A1C value of 8.0%. Further, patients treated with metformin had 32% risk reduction for any diabetes related endpoint and a 42% reduction in risk from diabetes related complications. However, despite attempts at tight glycemic control, the median A1C values in both groups rose over time. The median A1C values in the metformin group were 6.7% in the first 5 years of the study, 7.9% in the second five years of the study and 8.3% in the last 5 years. The median A1C values of the conventional treatment group also deteriorated over the duration of the study, starting out at 7.5% in the first 5 years of the study, 8.5% in the second 5 years and 8.8% in the last 5 years. The normal range for A1C was defined as 4.5% - 6.2%. Given this deterioration of levels of glycemic control, regular monitoring and therapy changes are required to manage these patients.
Study Justification

The key findings of this literature review include:

- Intensive glucose monitoring (A1C) and glycemic control are associated with reductions in microvascular complications (Turner, 1998),
- Intensive glucose monitoring (A1C) and glycemic control increase life expectancy and quality of life for Type 2 diabetic patients (de Lissovoy, 2000),
- Intensive glucose monitoring (A1C) and glycemic control are not associated with reductions in risk of Proliferative Diabetic Retinopathy (PDR) and eye examinations are an important part of Type 2 diabetic care (Brown, 2003),
- Multi-factorial interventions including albumin screening slow the development of nephropathy (Gaede, 1999),
- Patients with Type 2 diabetes receive suboptimal care and few preventive screening services (Wisdom, 1997, Saaddine, 2002 and Koro, 2004),
- The status of diabetes as a significant risk factor for cardiovascular disease sets reduction of risk of cardiovascular disease as a primary disease management target for patients with Type 2 diabetes (Meigs, 2003),
- Disease management programs are associated with higher rates of preventive screening services (Sidorov, 2002),
- Many factors influence adequate glycemic control. Regular and continued monitoring is critical for patients with this disease (Turner, 1998).

The literature provides conclusive evidence relating glycemic control to reductions in risk for microvascular disease for patients with diabetes (DCCT, UKPDS, WESDR, Kumamoto, de
Lissovoy, Hoerger). The National Committee for Quality Assurance, American Diabetes Association and the Center for Medicare and Medicaid Services has collaborated on the Diabetes Quality Improvement Project (de Lissovoy, 2000). Within this initiative the rate of A1C testing is the measurement by which the quality of care for patients with Type 2 diabetes is assessed. UKPDS 34 has established the need for regular and ongoing monitoring of A1C values over lengthy periods of time for Type 2 diabetic patients (Turner, 1998).

While A1C monitoring and glycemic control are certainly important for patients with Type 2 diabetes, other preventive screening services must be considered as well. Prospective clinical trials such as DCCT and UKPDS demonstrate reductions in retinopathy as the result of intensive glycemic control. However, while reductions in background diabetic retinopathy are observed as the result of glycemic and blood pressure control, no change is observed in proliferative diabetic retinopathy (Brown, 2003). Proliferative diabetic retinopathy causes loss of vision and is detected during eye examinations. DCCT, Kumamoto and UKPDS also demonstrate the role urine albumin testing plays in monitoring Type 2 diabetes. All three of these studies demonstrate glycemic control delays the onset of nephropathy as measured by albumin testing.

The literature also establishes the importance of monitoring cardiovascular risk factors (Morrish, Mukamal, Haffner, LIPID Trial, CARE Trial and the Heart Protection Study Group). Monitoring and controlling lipids is associated with reductions in cardiovascular events and death for both patients with and without Type 2 diabetes. Studies have established risk factor equivalence of diabetes and previous cardiovascular events for cardiac mortality (Mukamal and Haffner). While patients with Type 2 diabetes are at significant increased risk for cardiovascular
Disease studies to date have failed to establish reductions in risk from cardiovascular disease can be achieved as the result of glycemic control.

For patients with Type 2 diabetes A1C testing and control of glycemia is well understood as it relates to reductions of microvascular co-morbidities. Lipid testing and control of dyslipidemia is well understood as it relates to reductions in macrovascular co-morbidities. Diabetes is a complex disease requiring additional screening services. A gap exists in the literature related to the impact of multi-faceted screening services (A1C testing, eye examinations, lipids testing and albumin testing) on cost, utilization and health outcomes. While de Lissovoy reports reduced costs from glycemic control, Hoerger reports increases in costs from A1C monitoring and glycemic control accompanied by lipids testing and reductions in serum cholesterol. Sidorov reports lower costs, fewer inpatient admissions, fewer emergency department (ED) visits and greater use of outpatient professional services for diabetic patients who participate in disease management programs. Increased rates of screening services are observed for such patients as well.

The literature does not provide evidence to answer two critical questions:

- Which preventive screenings services are most important in reducing costs and utilization for patients with Type 2 diabetes?
- Which preventive screening services are most important in improving health outcomes by delaying the onset of microvascular or macrovascular disease?

This study seeks to contribute to the literature in understanding the impact preventive screening services (A1C testing, eye examinations, lipids testing and albumin testing) have on costs, utilization and presence of both microvascular and macrovascular disease.
CHAPTER THREE – STUDY DESIGN AND METHODS

This empirical study seeks to determine which preventive screening services or what combination of preventive screening services are most effective in improving outcomes for patients with Type 2 diabetes. This chapter includes four sections. The first section describes the setting for this study. The second section of this chapter details the patient selection process. The third section of this chapter defines study variables and the fourth section describes the analytic methods used to complete this analysis.

Setting

Data for this study are provided by Regence Blue Shield of Idaho. This organization is an independent licensee of the Blue Cross and Blue Shield Association and finances healthcare for 270,000 persons in Idaho and 2 Washington counties. The source of these data is the internal claim processing system for medical claims and the external claims processing intermediary system for pharmaceutical claims. Data extraction includes all medical and drug claims paid for patients with Type 2 diabetes in the service period from 8/1/2000 through 7/31/2003. To compensate for claims incurred but not yet reported, a three month run out period is used, selecting all claims paid by 10/31/2003. The data provided for this study includes a masked patient id and limited demographic data to protect the confidentiality of these patient records.

Selection of Patients for Analysis

In three years of health services data provided for this study, 7011 patient records include a physician’s diagnosis for diabetes mellitus (see Appendix A.1 – Definition of Diabetic Patient). This study includes both a base year defining factors that influence outcomes for Type 2 diabetic
patients and a 2 year follow-up period to assess such outcomes. The base year of this study is defined individually for each patient based on one full year’s of data from the date of the first medical or pharmaceutical claim following 8/1/2000. The follow-up period for this analysis is defined by medical and pharmaceutical claims after the base year for each patient and ending 7/31/2003.

The patient selection algorithm is detailed in Figure 3.1a - Patient Selection Algorithm for Cost Analysis and Figure 3.1b – Patient Selection Algorithm Utilization & Health Outcomes Analysis. The SQL script for creating study segmentation study flags is provided in Appendix A.2 - Patient Selection Script. The table created for categorization is called segmentation.

2390 of the 7011 patients in this dataset do not have a diabetes mellitus diagnosis by 7/31/2001. Records for these patients are removed from this analysis. Of the 4621 patients with a diagnosis of diabetes mellitus in the first year of this study 163 patients have first year costs that exceed two standard deviations of mean total costs ($23,244). Since this study seeks to determine the impact preventive health screening services has on follow-up period outcomes, records for these cost outlier patients are removed. Patients with health care costs that exceed two standard deviations of the mean are assumed to be too sick to benefit from preventive health screening services. 548 patient records are excluded from this study based on their Medicare status to ensure complete data capture. Regence Blue Shield of Idaho serves as a secondary financial responsible party for patients with Medicare. Claims processed for these patients do not represent the full cost of providing health care services for such patients.

Cost analysis includes patients with both medical and pharmaceutical claims in the base year of this study and claim activity during the follow-up period (2632 patient records). Analysis of utilization and health outcomes includes patients with claim activity during the follow-up
period (3897 patient records). Patient records for this analysis are randomly assigned to a single study group and a single validation study group.

**Patient Selection Algorithm for Study Segmentation**

7011 Total Patients Medical Claim
ICD9 Diagnosis Diabetes Mellitus
Between ‘8/1/2000’ and ‘7/31/2003’

4621 Total Patients Eligible for Study

Less 163 Total Patients Excluded as Cost Outliers in Base Year

Less 548 Total Patients Excluded as Medicare Patients

Less 1269 Total Patients Excluded as No Drug Claims in Base Year

Less 9 Total Patients Excluded as No Activity in Follow-Up Period

2632 Total Patients in Cost Study

*Figure 3.1a – Patient Selection Algorithm for Cost Analysis*
Patient Selection Algorithm for Study Segmentation

7011 Total Patients Medical Claim
ICD9 Diagnosis Diabetes Mellitus
Between ‘8/1/2000’ and ‘7/31/2003’

4621 Total Patients Eligible for Study

Less 163 Total Patients Excluded as Cost Outliers in Base Year

Less 548 Total Patients Excluded as Medicare Patients

Less 13 Total Patients Excluded as No Activity in Follow-Up Period

1944 Total Patients in Utilization/Health Outcomes Study
1953 Total Patients in Utilization/Health Outcomes

Figure 3.1b – Patient Selection Algorithm for Utilization & Health Outcomes Analysis
Study Variables

The data received from Regence Blue Shield of Idaho includes two tables; one for medical claims and a second for drug claims. The medical claims table includes 939,972 rows related to claim information recorded on hospital claim forms (UB92) and professional claim forms (HCFA1500). The drug claims table includes 476,033 rows related to claims information from filling prescriptions.

These two tables are normalized and stored in a Microsoft SQL Server Version 8.0 database. Normalization is a computer science concept that thematically groups data into separate tables. Normalization has many advantages including reductions in data redundancy and update anomalies (Connolly, 2002). The result of this normalization process is presented in Appendix A.3 - Normalized Claim Data Model.

The data structures included in the medical and drug claim data model provide the basis for building a number of patient-specific variables used in this analysis. These patient-specific variables are divided into three classes; independent, covariate and dependent variables. The independent variables are drawn from the study hypotheses that health screening services improve outcomes for Type 2 diabetic patients. These independent variables include base year indicators for eye exams, A1C testing, lipids testing and albumin testing. The control variables include those factors expected to influence outcomes beyond those variables of interest in this study. These variables include age, gender, a flag for any base year co-morbid disease, base year sum of Rbrvs, base year total number of professional visits, base year sum of professional Rbrvs, base year flag for microvascular co-morbid disease, base year flag for macrovascular co-morbid disease and base year flag for major depressive disorders. Outcome variables include follow-up
period costs, utilization and changes in health outcomes. An overview of the study design is presented in Figure 3.2 - Study Design.

**Study Variables**

**INDEPENDENT**

I.1 Indicator of Eye Exam  
I.2 Indicator of A1C Test  
I.3 Indicator of Lipids Test  
I.4 Indicator of Albumin Test

**DEPENDENT**

D.1 Follow-up Period Costs  
D.2 Follow-up Period Costs Changes  
D.3 Follow-Up Period ED Visits  
D.4 Follow-Up Period Inpatient Admits  
D.5 Follow-Up Period Hypertension  
D.6 Follow-up Period Dyslipidemia  
D.7 Follow-up Period Cardiac  
D.8 Follow-up Period Stroke  
D.9 Follow-Up Period Nephropathy  
D.10 Follow-Up Period ESRD  
D.11 Follow-Up Period Retinopathy  
D.12 Follow-Up Period Blindness  
D.13 Follow-Up Period Neuropathy  
D.14 Follow-Up Period LEA

**CONTROL**

C.1 Age  
C.2 Gender  
C.3 Base Year Co-Morbid Flag  
C.4 Base Year Macrovascular Flag  
C.5 Base Year Microvascular Flag  
C.6 Base Year Co-Morbid Rbrvs  
C.7 Base Year Professional Visits  
C.8 Base Year Professional Rbrvs  
C.9 Base Year Depression Flag

*Figure 3.2 Study Design*

Raw data provided for this study is transformed using data warehousing techniques to support this analysis (see Figure 3.3 -Preventive Screening Analytical Data Model). The table segmentation is detailed in this chapter in selection of patients for analysis. New database tables called *analysis_factors, rulelog, analysis_tests* and *analysis_outcomes* are constructed using cursors and a series of stored procedures.

A cursor is a programming language construct used to step through a database table and perform a series of programming tasks. The script used to create the tables *analysis_factors* and
rulelog is included in Appendix B.1 – Create Patient-Specific Factors. All patients included in this analysis are ordered and each patient is selected one at a time in order to execute a number of stored procedures for this patient. A stored procedure is a pre-compiled block of code that accepts parameters (in this case the patient identification and a date) and returns a value to the original code based on the passed parameters.

Figure 3.3 – Preventive Screening Analytical Data Model
Control Variables

Figure 3.2 - Study design details 9 control variables. These variables are described as follows.

**C.1 Age:** The control variable *analysis_factors.age* is an integer value returned by the stored procedure proc_age (see Appendix B.2 – Stored Procedure Age). This stored procedure accepts a patient identification and a date and returns the patient’s age as of that date. This analysis calculates age at the end of the base year (7/31/2001).

**C.2 Sex:** The control variable *analysis_factors.gender* is an integer value returned by the stored procedure proc_gender (see Appendix B.3 – Stored Procedure Gender). This stored procedure accepts a patient identification and returns the patient’s gender. While the source data model stores text values of ‘Male’ and ‘Female’ for gender, this stored procedure returns an integer value; 0 for female and a 1 for male.

**C.3 Chflag:** The control variable *analysis_factors.chflag* is an integer value calculated in the create analysis_factors script (see Appendix B.1 – Create Patient-Specific Factors). This script evaluates each patient for the presence of base year macrovascular disease (hypertension, dyslipidemia, cardiac, or stroke) or microvascular disease (nephropathy, end stage renal disease, retinopathy, blindness, neuropathy or lower extremity amputation). A value of ‘1’ is calculated for this variable if any of these co-morbid diseases are present. Otherwise a value of ‘0’ is calculated for this variable.

**C.4 Macflag:** The control variable *analysis_factors.macflag* is an integer value calculated in the create analysis_factors script (see Appendix B.1 – Create Patient-Specific Factors). This script evaluates each patient for the presence of base year hypertension,
dyslipidemia, cardiac, or stroke. A value of ‘1’ is calculated for this variable if any of these co-morbid diseases are present. Otherwise a value of ‘0’ is calculated for this variable.

An indication of hypertension (high blood pressure) in the base year is stored as an integer value returned by the stored procedure proc_hypertension (see Appendix B.4 – Stored Procedure Hypertension). This stored procedure accepts a patient identification, a start date and an ending date and returns the patient’s hypertension status based on claims processed within the dates provided. If the patient is determined to have this co-morbidity a value of 1 is returned. If evidence does not exist indicating the patient has hypertension a value of 0 is returned. Evidence of hypertension includes a diagnosis for this condition (see Appendix D.1 – Definition of Hypertension) on a professional (HCFA1500) claim form for a professional visit in which the provider and patient visit face-to-face (see Appendix C.1 – Definition of Professional Visit). If the patient is flagged as having hypertension an entry is recorded in the rulelog table for audit purposes.

An indication of dyslipidemia (abnormal blood lipid levels) in the base year is stored as an integer value returned by the stored procedure proc_dyslipidemia (see Appendix B.5 – Stored Procedure Dyslipidemia). This stored procedure accepts a patient identification, a start date and an ending date and returns the patient’s dyslipidemia status based on claims processed within the dates provided. If the patient is determined to have this co-morbidity a value of 1 is returned. If evidence does not exist indicating the patient has dyslipidemia a value of 0 is returned. Evidence of dyslipidemia includes a diagnosis for this condition (see Appendix D.2 – Definition of Dyslipidemia) on a professional (HCFA1500) claim form for a professional visit in which the provider and patient visited face-to-face (see Appendix C.1 – Definition of Professional Visit). If
the patient is flagged as having dyslipidemia an entry is recorded in the *rulelog* table for audit purposes.

An indication of cardiac co-morbidity in the base year is stored as an integer value returned by the stored procedure `proc_cardiac` (see Appendix B.6 – Stored Procedure Cardiac). Cardiac co-morbidity status is defined as the presence of a diagnosis indicating congestive heart failure (the inability of the heart to pump blood to the body) or ischemic heart disease (deficiency in the blood supply to the heart related to blockage of arterial blood vessels). This stored procedure accepts a patient identification, a start date and an ending date and returns the patient’s dyslipidemia status based on claims processed within the dates provided. If the patient is determined to have this co-morbidity a value of 1 is returned. If evidence does not exist indicating the patient has cardiac co-morbidity a value of 0 is returned. Evidence of cardiac co-morbidity includes a diagnosis for this condition (see Appendix D.3 – Definition of Cardiac) on either a hospital-based claim form (UB-92) or a professional (HCFA1500) claim form for a professional visit in which the provider and patient visited face-to-face (see Appendix C.1 – Definition of Professional Visit). If the patient is flagged as having cardiac co-morbidity an entry is recorded in the *rulelog* table for audit purposes.

An indication of stroke in the base year is stored as an integer value returned by the stored procedure `proc_stroke` (see Appendix B.7 – Stored Procedure Stroke). This stored procedure accepts a patient identification, a start date and an ending date and returns the patient’s stroke status based on claims processed within the dates provided. If the patient is determined to have this co-morbidity a value of 1 is returned. If evidence does not exist indicating the patient has a stroke a value of 0 is returned. Evidence of a stroke includes a diagnosis for this condition (see Appendix D.4 – Definition of Stroke) on either a hospital-based claim form (UB-92) or a
professional (HCFA1500) claim form for a professional visit in which the provider and patient visited face-to-face (see Appendix C.1 – Definition of Professional Visit). If the patient is flagged as having a stroke an entry is recorded in the rulelog table for audit purposes.

**C.5 Micflag:** The control variable `analysis_factors.micflag` is an integer value calculated in the create analysis_factors script (see Appendix B.1 – Create Patient-Specific Factors). This script evaluates each patient for the presence of base year nephropathy, end stage renal disease, retinopathy, blindness, neuropathy or lower extremity amputation. A value of ‘1’ is calculated for this variable if any of these co-morbid diseases are present. Otherwise a value of ‘0’ is calculated for this variable.

An indication of nephropathy (micro vascular complications of the kidney) in the base year is stored as an integer value returned by the stored procedure proc_renal (see Appendix B.8 – Stored Procedure Nephropathy). This stored procedure accepts a patient identification, a start date and an ending date and returns the patient’s nephropathy status (including end stage renal disease) based on claims processed within the dates provided. If the patient is determined to have this co-morbidity a value of 1 is returned. If evidence does not exist indicating the patient has nephropathy a value of 0 is returned. Evidence of nephropathy includes a diagnosis for this condition (see Appendix D.5 – Definition of Nephropathy) on either a hospital-based claim form (UB-92) or a professional (HCFA1500) claim form for a professional visit in which the provider and patient visited face-to-face (see Appendix C.1 – Definition of Professional Visit). If the patient is flagged as having nephropathy an entry is recorded in the rulelog table for audit purposes.

An indication of retinopathy (micro vascular complications of the eyes) in the base year is stored as an integer value returned by the stored procedure proc_retinal (see Appendix B.9 –
Stored Procedure Retinopathy). This stored procedure accepts a patient identification, a start date and an ending date and returns the patient’s retinopathy status (including blindness) based on claims processed within the dates provided. If the patient is determined to have this co-morbidity a value of 1 is returned. If evidence does not exist indicating the patient has retinopathy a value of 0 is returned. Evidence of retinopathy includes a diagnosis for this condition (see Appendix D.6 – Definition of Retinopathy) on either a hospital-based claim form (UB-92) or a professional (HCFA1500) claim form for a professional visit in which the provider and patient visited face-to-face (see Appendix C.1 – Definition of Professional Visit and Appendix C.2 – Definition of Eye Exam Visit). If the patient is flagged as having retinopathy an entry is recorded in the rulelog table for audit purposes.

An indication of neuropathy (micro vascular complications involving lower extremities) in the base year is stored as an integer value returned by the stored procedure proc_neuro (see Appendix B.10 – Stored Procedure Neuropathy). This stored procedure accepts a patient identification, a start date and an ending date and returns the patient’s neuropathy status (including lower extremity amputation) based on claims processed within the dates provided. Evidence of neurological co-morbid diseases includes diabetes with neurological or circulatory manifestations, cellulitis or skin infections of the lower extremities, gangrene, atherosclerosis (fatty deposits in the arteries) of extremities, and chronic neurological ulcers or lower extremity amputations. If the patient is determined to have this co-morbidity a value of 1 is returned. If evidence does not exist indicating the patient has neuropathy a value of 0 is returned. Evidence of neuropathy includes a diagnosis for this condition (see Appendix D.7 – Definition of Neuropathy) on either a hospital-based claim form (UB-92) or a professional (HCFA1500) claim form for a professional visit in which the provider and patient visited face-to-face (see Appendix
C.1 – Definition of Professional Visit). If the patient is flagged as having neuropathy an entry is recorded in the rulelog table for audit purposes.

**C.6 Chrbrvs:** The control variable analysis_factors.chrbrvs is a numeric value calculated in an update of analysis_factors. The script to complete this task is provided in Appendix B.11 – Update Patient-Specific Factors. Chrbrvs represents the intensity of professional services provided to the Type 2 diabetic patient in the base year of this study for services related to treating co-morbid disease. Values for each professional visit are assigned by CPT4 code (see Appendix C.1 – Definition of Professional Visit).

**C.7 Visits:** The control variable analysis_tests.visits is an integer value returned by the stored procedure proc_visits (see Appendix B.12 – Stored Procedure Visits) called by the script to calculate base year services and screening services (see Appendix B.12 – Create Patient-Specific Services). This stored procedure accepts a patient identification, a start date and an ending date and returns the total number of professional services for the Type 2 diabetic patient in the time period provided.

**C.8 Totrbrvs:** The control variable analysis_tests.totrbrvs is a numeric value returned by the stored procedure proc_rbrvs (see Appendix B.13 – Stored Procedure Rbrvs) called by the script to calculate base year services and screening services (see Appendix B.12 – Create Patient-Specific Services). This stored procedure accepts a patient identification, a start date and an ending date and returns the sum of Rbrvs values for all professional services for the Type 2 diabetic patient in the time period provided.

**C.9 Depflag:** The control variable analysis_factors.depression is an integer value returned by the stored procedure proc_depression (see Appendix B.15 – Stored Procedure Depression). This stored procedure accepts a patient identification, start date and an ending date
and return’s this patient’s major depression status based on medical claims processed within the
time period provided. If the patient is determined to have this co-morbidity a value of 1 is
returned. If evidence does not exist indicating this patient had a major depressive disorder a
value of 0 is returned. Evidence of a major depressive disorder includes a diagnosis for this
condition (see Appendix D.8 Definition of Major Depressive Disorder) on either a UB92 or a
HCFA1500 claim form. If the diagnosis occurred on a HCFA1500, this professional visit must
have been a face-to-face psychiatric or evaluation and management visit (see Appendix C.1 –
Definition of Professional Visit and Appendix C.3 – Definition of Psychiatric Office Visit). If the
patient was flagged as having depression during the base year and entry was recorded in the
rulelog table for audit purposes.

Table 3.1 – Processing of Control Variables

<table>
<thead>
<tr>
<th>Reference</th>
<th>Control Variable</th>
<th>Brief Description</th>
<th>Processing Script</th>
<th>Stored Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.1</td>
<td>age</td>
<td>Patient Age 7/31/2001</td>
<td>create analysis_factors</td>
<td>proc_age</td>
</tr>
<tr>
<td>C.2</td>
<td>sex</td>
<td>Patient Gender</td>
<td>create analysis_factors</td>
<td>proc_gender</td>
</tr>
<tr>
<td>C.3</td>
<td>chflag</td>
<td>Co-Morbid Disease</td>
<td>create analysis_factors</td>
<td>script</td>
</tr>
<tr>
<td>C.4</td>
<td>macflag</td>
<td>Macrovascular Disease</td>
<td>create analysis_factors</td>
<td>script</td>
</tr>
<tr>
<td>C.5</td>
<td>micflag</td>
<td>Microvascular Disease</td>
<td>create analysis_factors</td>
<td>script</td>
</tr>
<tr>
<td>C.6</td>
<td>chbrvs</td>
<td>Co-Morbid Rbrvs</td>
<td>update analysis_factors</td>
<td>script</td>
</tr>
<tr>
<td>C.7</td>
<td>visits</td>
<td>Count Pro Services</td>
<td>create analysis_tests</td>
<td>proc_visits</td>
</tr>
<tr>
<td>C.8</td>
<td>totbrvs</td>
<td>Professional Rbrvs</td>
<td>create analysis_tests</td>
<td>proc_rbrvs</td>
</tr>
<tr>
<td>C.9</td>
<td>depflag</td>
<td>Depression</td>
<td>create analysis_factors</td>
<td>proc_depression</td>
</tr>
</tbody>
</table>

Independent Variables

Four independent variables are calculated for this study as shown in Figure 3.2 – Study
Design. Each of these variables is defined to measure the extent to which preventive screening
services are provided in the base year of the study for patients with Type 2 diabetes. These
measures include the presence of professional eye exams, the presence of laboratory blood A1C testing, the presence of laboratory blood lipids testing, and the presence of urine albumin testing for each patient in the base year of this study. These variables are calculated and stored in the database table `analysis_tests` (see Appendix B.12 – Create Patient-Specific Services).

I.1 Eye: The independent variable `analysis_tests.eyeexams` is an integer value returned by the stored procedure `proc_eyeexams` (see Appendix B.16 – Stored Procedure Eye Exams). This stored procedure accepts a patient identification, a start date and an ending date and returns a flag to indicate the presence of professional eye exam during the date range provided. The presence of eye examinations during this time period returns a value of ‘1’. If no evidence for an eye examination exists during the time period provided a value of ‘0’ is returned and stored in this variable. The indicator for professional eye examinations is based on HCFA1500 claims processed with a CPT4 code indicating such an exam is performed (see Appendix C.2 – Definition of Eye Exam Visit).

I.2 A1C: The independent variable `analysis_tests.a1ctests` is an integer value returned by the stored procedure `proc_a1c` (see Appendix B.17 – Stored Procedure A1C Testing). This stored procedure accepts a patient identification, a start date and an ending date and returns a flag to indicate the presence of A1C testing during the date range provided. The presence of A1C testing during this time period returns a value of ‘1’. If no evidence for A1C testing exists during the time period provided a value of ‘0’ is returned and stored in this variable. The indicator for A1C testing is based on HCFA1500 claims processed with a CPT4 code indicating such an exam is performed as shown in Table 3.2 – Procedure Codes Identifying A1C Testing.
Table 3.2 – Procedure Codes Identifying A1C Testing

<table>
<thead>
<tr>
<th>Cpt4 Code</th>
<th>Short Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>83036</td>
<td>Hemoglobin; Glycated</td>
</tr>
</tbody>
</table>

I.3 Lipid: The independent variable analysis_tests.lipidtests is an integer value returned by the stored procedure proc_lipids (see Appendix B.18 – Stored Procedure A1C Testing). This stored procedure accepts a patient identification, a start date and an ending date and returns a flag to indicate the presence of lipid testing during the date range provided. The presence of lipid testing during this time period returns a value of ‘1’. If no evidence for lipid testing exists during the time period provided a value of ‘0’ is returned and stored in this variable. The indicator for lipid testing is based on HCFA1500 claims processed with a CPT4 code indicating such an exam is performed as shown in Table 3.3 – Procedure Codes Identifying Lipid Testing.

Table 3.3 – Procedure Codes Identifying Lipid Testing

<table>
<thead>
<tr>
<th>Cpt4 Code</th>
<th>Short Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>80061</td>
<td>Lipid Panel</td>
</tr>
<tr>
<td>83715</td>
<td>Lipoprotein, Blood, Electrophoretic Separation</td>
</tr>
<tr>
<td>83716</td>
<td>Blood Lipoprotein; High Resolution Fractionation</td>
</tr>
<tr>
<td>83721</td>
<td>Lipoprotein, Direct Measurement</td>
</tr>
</tbody>
</table>

I.4 Albumin: The independent variable analysis_tests.albumintests is an integer value returned by the stored procedure proc_albumin (see Appendix B.19 – Stored Procedure Albumin Testing). This stored procedure accepts a patient identification, a start date and an ending date and returns a flag to indicate the presence of albumin testing during the date range provided. The presence of albumin testing during this time period returns a value of ‘1’. If no evidence for
albumin testing exists during the time period provided a value of ‘0’ is returned and stored in this variable. The indicator for albumin testing is based on HCFA1500 claims processed with a CPT4 code indicating such an exam is performed as shown in Table 3.4 – Procedure Codes Identifying Albumin Testing.

Table 3.4 – Procedure Codes Identifying Albumin Testing

<table>
<thead>
<tr>
<th>Cpt4 Code</th>
<th>Short Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>82042</td>
<td>Albumin; Urine, Quantitative</td>
</tr>
<tr>
<td>82043</td>
<td>Albumin; Urine, Microalbumin, Quantitative</td>
</tr>
<tr>
<td>82044</td>
<td>Albumin; Urine, Microalbumin, Semi-quantitative</td>
</tr>
<tr>
<td>84155</td>
<td>Protein; Total, Except Refractometry</td>
</tr>
<tr>
<td>84165</td>
<td>Protein; Electrophoretic Fractionation and Quantitative AND</td>
</tr>
<tr>
<td>81050</td>
<td>Volume Measurements for Timed Collection</td>
</tr>
</tbody>
</table>

**Dependent Variables**

Fourteen dependent variables are listed in Table 3.2 – Study Design. The script used to create the database table *analysis_outcomes* is included in Appendix B.20 – Create Patient-Specific Outcomes. All patients included in this analysis are ordered and each patient is selected one at a time in order to execute a number of stored procedures for each patient. A number of dependent variables are processed by this script. Dependent variables listed in Table 3.5 – Processing of Dependent Variables includes dependent variable outcomes related to costs, utilization and health outcomes.
Table 3.5 – Processing of Dependent Variables

<table>
<thead>
<tr>
<th>Reference</th>
<th>Control Variable</th>
<th>Brief Description</th>
<th>Stored Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.1</td>
<td>totcost</td>
<td>Follow-Up Total Costs</td>
<td>proc_costs</td>
</tr>
<tr>
<td>D.2</td>
<td>deltaflg</td>
<td>Follow-Up Cost Changes</td>
<td>script</td>
</tr>
<tr>
<td><strong>Utilization</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.3</td>
<td>resulted</td>
<td>Follow-Up ED Visits</td>
<td>proc_utils</td>
</tr>
<tr>
<td>D.4</td>
<td>resultip</td>
<td>Follow-Up Admissions</td>
<td>proc_utils</td>
</tr>
<tr>
<td><strong>Health Outcomes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.5</td>
<td>hypchng</td>
<td>Follow-Up Hypertension</td>
<td>proc_hypertension</td>
</tr>
<tr>
<td>D.6</td>
<td>dyschng</td>
<td>Follow-Up Dyslipidemia</td>
<td>proc_dyslipidemia</td>
</tr>
<tr>
<td>D.7</td>
<td>carchng</td>
<td>Follow-Up Cardiac</td>
<td>proc_cardiac</td>
</tr>
<tr>
<td>D.8</td>
<td>stkchng</td>
<td>Follow-Up Stroke</td>
<td>proc_stroke</td>
</tr>
<tr>
<td>D.9</td>
<td>renchng</td>
<td>Follow-Up Nephropathy</td>
<td>proc_renal</td>
</tr>
<tr>
<td>D.10</td>
<td>esrchng</td>
<td>Follow-Up ESRD</td>
<td>proc_renal</td>
</tr>
<tr>
<td>D.11</td>
<td>retchng</td>
<td>Follow-Up Retinopathy</td>
<td>proc_retinal</td>
</tr>
<tr>
<td>D.12</td>
<td>blichng</td>
<td>Follow-Up Blindness</td>
<td>proc_retinal</td>
</tr>
<tr>
<td>D.13</td>
<td>neuchng</td>
<td>Follow-Up Neuropathy</td>
<td>proc_neuro</td>
</tr>
<tr>
<td>D.14</td>
<td>ampchng</td>
<td>Follow-Up LEA</td>
<td>proc_neuro</td>
</tr>
</tbody>
</table>

**D.1 Totcost:** The dependent variable `analysis_outcomes.resultcosts` is numeric value returned by the stored procedure `proc_costs` (see Appendix B.21 – Stored Procedure Costs). This stored procedure accepts a patient identification, a start date and an ending date and returns and stores the total medical and pharmaceutical claims costs for this patient during the date range provided.

**D.2 Deltaflg:** The dependent variable `analysis_outcomes.deltacosts` is an integer value calculated within the database table creation script (see Appendix B.20 – Create Patient-Specific Outcomes). The stored procedure `proc_costs` is executed for each patient’s base year and the follow-up period. A comparison is made between base year costs and follow-up period costs. If follow-up period costs exceed base year costs by more than 17.3% this change flag is set to ‘1’.
follow-up period costs do not exceed base year costs by more than 17.3% this flag is set to ‘0’. The value 17.3% is chosen based on Center for Medicaid and Medicare Services (CMS) reports of average annual growth for national health expenditures in 2001 (7.3%) and 2002 (9.3%) (Heffler, 2004).

D3. Resulted: The dependent variable \textit{analysis_outcomes.result\_er} is an integer value returned by the stored procedure proc\_utils (see Appendix B.22 – Stored Procedure Utilization). This stored procedure accepts a patient identification, a start date and an ending date and returns and stores the total number of emergency department visits (ED) for the patient in the date range provided. An ED visit is based on the presence of a hospital-based UB-92 claim form with revenue codes as indicated in Table 3.6 – Revenue Codes Indicating Emergency Department Visits. Patients admitted through the ED are excluded from this total.

\textit{Table 3.6 – Revenue Codes Indicating Emergency Department Visits}

<table>
<thead>
<tr>
<th>UB92 Revenue Code</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>00450</td>
<td>Emergency Room General Classification</td>
</tr>
</tbody>
</table>

D4. Resultip: The dependent variable \textit{analysis_outcomes.result\_ip} is an integer value returned by the stored procedure proc\_utils (see Appendix B.22 – Stored Procedure Utilization). This stored procedure accepts a patient identification, a start date and an ending date and returns and stores the total number of inpatient admissions for this patient in the date range provided.
Table 3.7 – Revenue Codes Indicating Acute Inpatient Admission

<table>
<thead>
<tr>
<th>UB92 Revenue Code</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>00100</td>
<td>All-Inclusive RATE All-Inclusive Room and Board</td>
</tr>
<tr>
<td>00101</td>
<td>All-Inclusive RATE All-Inclusive Room and Board</td>
</tr>
<tr>
<td>00110</td>
<td>Room &amp; Board Private Medical or General Bed Genera</td>
</tr>
<tr>
<td>00111</td>
<td>Room &amp; Board Private Medical or General Medical/Su</td>
</tr>
<tr>
<td>00113</td>
<td>Room &amp; Board Private Medical or General Pediatric</td>
</tr>
<tr>
<td>00114</td>
<td>Room &amp; Board Private Medical or General Psych.</td>
</tr>
<tr>
<td>00116</td>
<td>Room &amp; Board Private Medical or General Detox.</td>
</tr>
<tr>
<td>00117</td>
<td>Room &amp; Board Private Medical or General Oncology</td>
</tr>
<tr>
<td>00120</td>
<td>Room &amp; Board - Semi-private Two Bed General Class.</td>
</tr>
<tr>
<td>00121</td>
<td>Room &amp; Board - Semi-private Two Bed Medical/Surg.</td>
</tr>
<tr>
<td>00122</td>
<td>Room &amp; Board - Semi-private Two Bed OB</td>
</tr>
<tr>
<td>00123</td>
<td>Room &amp; Board - Semi-private Two Bed Pediatric</td>
</tr>
<tr>
<td>00124</td>
<td>Room &amp; Board - Semi-private Two Bed Psychiatric</td>
</tr>
<tr>
<td>00127</td>
<td>Room &amp; Board - Semi-private Two Bed Oncology</td>
</tr>
<tr>
<td>00128</td>
<td>Room &amp; Board - Semi-private Two Bed Rehabilitation</td>
</tr>
<tr>
<td>00130</td>
<td>Semi-Private - Three and Four Beds General Class.</td>
</tr>
<tr>
<td>00138</td>
<td>Semi-Private - Three and Four Beds Rehab.</td>
</tr>
<tr>
<td>00160</td>
<td>Other Room &amp; Board General Classification</td>
</tr>
<tr>
<td>00200</td>
<td>Intensive Care General Classification</td>
</tr>
<tr>
<td>00201</td>
<td>Intensive Care Surgical</td>
</tr>
<tr>
<td>00202</td>
<td>Intensive Care Medical</td>
</tr>
<tr>
<td>00203</td>
<td>Intensive Care Pediatric</td>
</tr>
<tr>
<td>00204</td>
<td>Intensive Care Psychiatric</td>
</tr>
<tr>
<td>00206</td>
<td>Intensive Care Intermediate ICU</td>
</tr>
<tr>
<td>00207</td>
<td>Intensive Care Burn Care</td>
</tr>
<tr>
<td>00209</td>
<td>Intensive Care Other Intensive Care</td>
</tr>
<tr>
<td>00210</td>
<td>Coronary Care General Classification</td>
</tr>
<tr>
<td>00211</td>
<td>Coronary Care Myocardial Infarction</td>
</tr>
<tr>
<td>00213</td>
<td>Coronary Care Heart Transplant</td>
</tr>
<tr>
<td>00214</td>
<td>Coronary Care Intermediate-CCU</td>
</tr>
</tbody>
</table>

An acute inpatient admission is based on the presence of a hospital-based UB-92 claim form with revenue codes as indicated in Table 3.7 – Revenue Codes Indicating Acute Inpatient Admission.

**D.5 Hypchng:** The dependent variable `analysis_outcomes.hypchange` is an integer value calculated during creation of `analysis_outcomes` (see Appendix B.20 – Create Patient-Specific
Outcomes). This health outcome variable measures the onset of hypertension in the follow-up period of this study. The stored procedure proc_hypertension (see Appendix B.4 – Stored Procedure Hypertension) is executed for each patient in both the base year and the follow-up period. If this co-morbid disease exists for the patient in the follow-up period but not in the base year this value is set to ‘1’. Under any other condition this flag is set to ‘0’.

**D.6 Dyschng:** The dependent variable analysis_outcomes.dyschange is an integer value calculated during creation of analysis_outcomes (see Appendix B.20 – Create Patient-Specific Outcomes). This health outcome variable measures the onset of dyslipidemia in the follow-up period of this study. The stored procedure proc_dyslipidemia (see Appendix B.5 – Stored Procedure Dyslipidemia) is executed for each patient in both the base year and the follow-up period. If this co-morbid disease exists for the patient in the follow-up period but not in the base year this value is set to ‘1’. Under any other condition this flag is set to ‘0’.

**D.7 Carchng:** The dependent variable analysis_outcomes.carchange is an integer value calculated during creation of analysis_outcomes (see Appendix B.20 – Create Patient-Specific Outcomes). This health outcome variable measures the onset of cardiac disease in the follow-up period of this study. The stored procedure proc_cardiac (see Appendix B.6 – Stored Procedure Cardiac) is executed for each patient in both the base year and the follow-up period. If this co-morbid disease exists for the patient in the follow-up period but not in the base year this value is set to ‘1’. Under any other condition this flag is set to ‘0’.

**D.8 Stkchng:** The dependent variable analysis_outcomes.stkchange is an integer value calculated during creation of analysis_outcomes (see Appendix B.20 – Create Patient-Specific Outcomes). This health outcome variable measures the onset of stroke in the follow-up period of this study. The stored procedure proc_stroke (see Appendix B.7 – Stored Procedure Stroke) is
executed for each patient in both the base year and the follow-up period. If this co-morbid disease exists for the patient in the follow-up period but not in the base year this value is set to ‘1’. Under any other condition this flag is set to ‘0’.

D.9 Renchng: The dependent variable *analysis_outcomes.renchange* is an integer value calculated during creation of *analysis_outcomes* (see Appendix B.20 – Create Patient-Specific Outcomes). This health outcome variable measures the onset of nephropathy in the follow-up period of this study. The stored procedure *proc_renal* (see Appendix B.8 – Stored Procedure Nephropathy) is executed for each patient in both the base year and the follow-up period. If this co-morbid disease exists for the patient in the follow-up period but not in the base year this value is set to ‘1’. Under any other condition this flag is set to ‘0’.

D.10 Esrchng: The dependent variable *analysis_outcomes.esrdchange* is an integer value calculated during creation of *analysis_outcomes* (see Appendix B.20 – Create Patient-Specific Outcomes). This health outcome variable measures the onset of end stage renal disease (ESRD) in the follow-up period of this study. The stored procedure *proc_renal* (see Appendix B.8 – Stored Procedure Nephropathy) is executed for each patient in both the base year and the follow-up period. If this co-morbid disease exists for the patient in the follow-up period but not in the base year this value is set to ‘1’. Under any other condition this flag is set to ‘0’.

D.11 Retchng: The dependent variable *analysis_outcomes.retchange* is an integer value calculated during creation of *analysis_outcomes* (see Appendix B.20 – Create Patient-Specific Outcomes). This health outcome variable measures the onset of retinopathy in the follow-up period of this study. The stored procedure *proc_retinal* (see Appendix B.9 – Stored Procedure Retinopathy) is executed for each patient in both the base year and the follow-up period. If this
co-morbid disease exists for the patient in the follow-up period but not in the base year this value is set to ‘1’. Under any other condition this flag is set to ‘0’.

D.12 Blichng: The dependent variable `analysis_outcomes.blindchange` is an integer value calculated during creation of `analysis_outcomes` (see Appendix B.20 – Create Patient-Specific Outcomes). This health outcome variable measures the onset of blindness in the follow-up period of this study. The stored procedure `proc_retinal` (see Appendix B.9 – Stored Procedure Retinopathy) is executed for each patient in both the base year and the follow-up period. If this co-morbid disease exists for the patient in the follow-up period but not in the base year this value is set to ‘1’. Under any other condition this flag is set to ‘0’.

D.13 Neuchng: The dependent variable `analysis_outcomes.neuchange` is an integer value calculated during creation of `analysis_outcomes` (see Appendix B.20 – Create Patient-Specific Outcomes). This health outcome variable measures the onset of neuropathy in the follow-up period of this study. The stored procedure `proc_neuro` (see Appendix B.10 – Stored Procedure Neuropathy) is executed for each patient in both the base year and the follow-up period. If this co-morbid disease exists for the patient in the follow-up period but not in the base year this value is set to ‘1’. Under any other condition this flag is set to ‘0’.

D.14 Ampchng: The dependent variable `analysis_outcomes.amputchange` is an integer value calculated during creation of `analysis_outcomes` (see Appendix B.20 – Create Patient-Specific Outcomes). This health outcome variable measures the onset of lower-extremity amputation (LEA) in the follow-up period of this study. The stored procedure `proc_neuro` (see Appendix B.10 – Stored Procedure Neuropathy) is executed for each patient in both the base year and the follow-up period. If this co-morbid disease exists for the patient in the follow-up period but not in the base year this value is set to ‘1’. Under any other condition this flag is set to ‘0’.
period but not in the base year this value is set to ‘1’. Under any other condition this flag is set to ‘0’.

Analytic Methods

The analytical process used in this analysis follows two major steps. The first includes exploratory analysis of study variables using a popular data mining technique. Self-Organizing Maps (SOMs) provide a visual, exploratory review of data to identify clusters of similar records. The second stage of this analysis includes statistical testing to quantify relationships discovered during this study.

Data mining is an emerging industry in which solutions to problems are sought from data (Vesanto, 2000). Advances in data storage technology and data mining techniques provide opportunities to explore large health services datasets such as those included in this study. This data visualization technique takes place in a technical computing environment using the tool MATLAB Version 6.1, Release 12.1. The Laboratory of Computer and Information Science (CIS) in the Department of Computer Science and Engineering at Helsinki University of Technology has built a SOM toolbox for the MATLAB computing environment (available for download at http://www.cis.hut.fi/projects/somtoolbox/download/).

A sample script used to conduct exploratory analysis is provided in Appendix B.23 – SOM Sample Script. Data for this analysis includes covariates, independent variables and each of the dependent variables under consideration. These data are organized in ASCII text files and read using a MATLAB command script. All continuous variables are range normalized between the values of zero and one. Next a map is trained and the components displayed. A SOM map is a multi-dimensional view of study data condensed to a two dimensional map. Data are placed
within neurons in a manner that maintains dispersion among these multiple dimensions. The unified distance matrix (u-matrix) displays each of these neurons in a color-coded fashion. The closer a neuron lays to each of its neighbors the darker the color. In this manner mathematical cluster of data; those closest in proximity to other observations, are easily identified. Finally, a review of the components used to build the u-matrix identifies the characteristics of observations assigned to each neuron.

Cluster analysis using self-organizing maps have a number of advantages over statistical-based cluster techniques:

1. This technical computing environment allows very fast training of a MAP and review of the map’s components.
2. This technique requires no a-prior knowledge of the data. In contrast to statistical techniques for cluster analysis, the number of clusters is not identified. This process is referred to as unsupervised learning (Turban, 2001).
3. This technique is visual in nature allowing for efficient exploratory analysis.

Cluster analysis in this study includes 2632 patient records from patients that include base year medical and pharmaceutical claims. The dependent variables under review include follow-up period costs; follow-up period costs changes, number of emergency department visits and acute inpatient admissions in the follow-up period. Health outcomes are assessed using the presence of macrovascular and microvascular disease in the follow-up period.

Statistical analysis follows cluster analysis, seeking to quantify relationships observed during the cluster analysis. This analysis includes 2632 patient records in cluster analysis and an additional 1269 patient records excluded from cluster analysis. These data represent patient records for which medical claim activity is present in the base year of this study but lack
pharmaceutical claim activity. These 3897 patient records are randomly assigned to a study
group (1944 patient records) and validation group (1953 patient records) using statistical
software SPSS Version 11.5. A comparison of means is completed among base year variables to
ensure comparability also using SPSS Version 11.5. Base year means between study and
validation are reviewed for age, gender, presence of depression, sum of Rbrvs for co-morbid
professional services, sum of Rbrvs for all professional services, professional visits, base year
ED utilization, base year acute inpatient admissions, indicator of eye exams, indicator of A1C
testing, indicator of lipid testing, indicator of albumin testing, presence of macrovascular disease
and the presence of microvascular disease in the base year of this study.

Next, bivariate correlations are computed between study covariate variables and each of
the dependent variables of interest. Based on high co linearity between these covariate variables
the variable with the strongest association (using the highest correlation coefficient) is chosen to
build a baseline regression model. For continuous utilization variables including number of
follow-up period emergency department (ED) visits and acute inpatient admissions, linear
regression is used. For binary health outcome variables including follow-up period hypertension,
dyslipidemia, cardiac, stroke, nephropathy, end stage renal disease (ESRD), retinopathy,
blindness, neuropathy and lower-extremity amputation (LEA), logistic regression is used.

Using the strongest covariate a baseline regression model is built and tested for both
covariate regression coefficient significance and overall model significance. Each of four base
years preventive screening service variables (EYE, A1C, LIPID, and ALBUMIN) are introduced
to this regression model. Regression coefficient significance and block model significance are
noted. If any of the four base years preventive screening services are significant and explain an
increased percentage of the dependent variable variance all combinations of screening services are tested.

Finally, in instances where regression models exhibit negative relationships with dependent variables (supporting study hypotheses) study findings are validated. This includes developing predicted values using significant regression models and comparing this predicted value with observed values in the validation group. Significant correlates between predicted values and observed values validate study findings. This cross-validation technique is very important given the investigative and exploratory nature of this analysis.
CHAPTER FOUR – STUDY FINDINGS

This research hypothesizes health-screening services (eye exams, A1C testing, lipids testing and albumin testing) reduce direct health care costs, reduce acute care utilization and improves health outcomes by delaying the onset of co-morbid disease. This empirical study specifically seeks to determine which preventive screening services or what combination of preventive screening services are most effective in improving outcomes for patients with Type 2 diabetes.

In the base year of this study a large number of Type 2 diabetic patients do not have evidence of preventive screenings services (n=1944). 38.9% of the study population has an eye examination. 46.6% of the study population has an indication of A1C testing in the base year. Lipid testing is performed in 33.5% of study participants while albumin testing is demonstrated in just 14.2% of the study population. Further, patients with A1C testing and lipids testing (30.1%), A1C testing and lipids testing and albumin testing (10.5%) and all 4 screenings (4.3%) also exhibit low rates.

This chapter contains four sections. The first section includes findings related to exploratory analysis. The second section details statistical findings. A third section provides a summary of chapter findings related to the research hypotheses. The fourth section presents validation results of this analysis.

EXPLORATORY ANALYSIS

Cluster analysis is exploratory and visual in nature and searches for data clusters in the study population. The techniques used in this study to perform cluster analysis are self-organizing maps. The findings of this exploratory cluster analysis are presented in three sections;
costs, utilization and health outcomes. A summary of exploratory clusters analysis is presented at
the end of this section.

**Costs**

The findings in this section relate to the research hypothesis that health-screening
services delivered in the base year of the study reduce direct health care costs in the follow-up
period. Exploratory findings are presented in two sections including follow-up period costs (sum
of medical and pharmaceutical claims) and follow-up period cost changes (percentage increase in
follow-up period total costs over the base year). This analysis includes follow-up period costs for
all patients with both medical and pharmaceutical claims in the base year of this study.
**Follow-up period Costs:** The unified distance matrix (U-matrix) is shown in Figure 4.1 Self-Organizing Map for Follow-up period Costs. This graphic displays mathematical proximity of each neuron to its neighboring neurons. The ‘closer’ a neuron is to its neighboring neurons the darker the color reflecting the shorter distance to these neighboring neurons. Darkened areas on the U-matrix therefore indicate clusters of similar patient characteristics.

The most prominent data clusters are observed near the top of this U-matrix. A review of the individual components used to build this U-matrix describes the characteristics of these clusters. These individual components are also provided in Figure 4.1 Self-Organizing Map for Follow-up period Costs.

The AGE component map shows these clusters include the younger patients in this study. The SEX component identifies these data clusters as having both male and female patients and the DEPFLAG component identifies at least some of these patients as having major depressive disorders. The three components indicating the use of professional services in the base year of this study (CHRBRVS, TOTRBRVS and VISITS) show these patients are seldom seen by a provider in the base year of this study. CHFLAG, MACFLAG and MICFLAG are indicators of the presence of co-morbid disease for these Type 2 diabetic patients. Patients in these cluster groupings did not show evidence of such conditions in the base year of this study. Health screening services of EYE, LIPID and ALBUMIN indicate these patients did not have these services performed in the base year of this study while A1C indicates some patients in these clusters had this screening service performed. Finally, the TOTCOST components shows the prominent clusters in this analysis incurred relatively low follow-up period medical and pharmaceutical claim costs.
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<th>VARIABLE STATUS</th>
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<td>Base year Flag for Macrovascular Co-Morbid Disease</td>
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</tr>
</tbody>
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*Figure 4.1 Self-Organizing Map for Follow-up Period Costs*
**Follow-up period Costs Changes:** The unified distance matrix (U-matrix) is shown in Figure 4.2 Self-Organizing Map for Follow-up period Cost Changes. This graphic displays mathematical proximity of each neuron to its neighboring neurons. The ‘closer’ a neuron is to its neighboring neurons the darker the color reflecting the shorter distance to these neighboring neurons. Darkened areas on the U-matrix therefore indicate clusters of similar patient characteristics.

The outcome variable for this cluster analysis is identified by the component name DELTAFLG. This dichotomous variable compares total claim costs for a patient in the base year and follow-up periods of this study. This flag is set to one if the patient’s follow-up period costs exceed base year costs by a rate higher than the overall rate of inflation of U.S. direct health expenditures during this same time period. This flag remains at zero if follow-up period costs did not exceed base year costs for direct medical expenditures.

A review of the U-matrix in Figure 4.2 Self-Organizing Map for Follow-up period Cost Changes does not indicate any prominent data clustering.
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</tr>
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<td>MICFLAG</td>
<td>Base year Flag for Microvascular Co-Morbid Disease</td>
<td>Dichotomous Covariate</td>
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<td>VISITS</td>
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*Figure 4.2 Self-Organizing Map for Follow-up Period Cost Changes*
Utilization

The findings in this section relate to the research hypothesis that health-screening services delivered in the base year of the study reduce acute care utilization in the follow-up period. Exploratory findings are presented in two sections including follow-up period utilization of the Emergency Department (ED) and follow-up period inpatient admissions.

Follow-up period ED Utilization: The unified distance matrix (U-matrix) is shown in Figure 4.3 Self-Organizing Map for Follow-up period ED Utilization. The outcome variable for this cluster analysis is identified by the component name RESULTED. This continuous variable records the total number of visits each patient made to an Emergency Department in the follow-up period.

The most prominent clusters on the U-matrix occur near the bottom. The AGE component map shows these prominent clusters occur in younger to middle age patients. The SEX component indicates some of these clusters are male and some of these clusters are female dominant. According to the DEPFLAG component some of these patients have major depressive disorders. A review of the CHRBRVS, TOTRBRVS and VISITS component maps indicate patients in these prominent clusters used few professional services in the base year. CHFLAG, MACFLAG and MICFLAG as indicators of co-morbid disease, show these patient clusters do not have evidence of any co-morbid diseases. EYE and ALBUMIN reveal such patients did not have these screening services in the base year. At least some patients in these clusters had A1C testing and LIPID testing in the base year of this study. Finally, RESULTED indicates patients in these prominent clusters did not seek treatment in the Emergency Department in the follow-up period.
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*Figure 4.3 Self-Organizing Map for Follow-up Period ED Utilization*
**Follow-up period Inpatient Admissions:** The unified distance matrix (U-matrix) is shown in Figure 4.4 Self-Organizing Map for Follow-up period Inpatient Admissions. The outcome variable for this cluster analysis is identified by the component name RESULTIP. This continuous variable records the total number of inpatient admission for each patient in the follow-up period.

The most prominent clusters on the U-matrix occur near the top middle to right. A review of the individual components used to build this U-matrix describes the characteristics of these clusters. These individual components are also provided in Figure 4.4 Self-Organizing Map for Follow-up period Inpatient Admissions.

The AGE component map shows these prominent clusters occur in younger to middle age patients. The SEX component indicates some of these clusters are male and some of these clusters are female dominant. According to the DEPFLAG component some of these patients have major depressive disorders. A review of the CHRBRVS, TOTRBRVS and VISITS component maps indicate patients in these prominent clusters used few professional services in the base year. CHFLAG, MACFLAG and MICFLAG as indicators of co-morbid disease, show these patient clusters do not have evidence of any co-morbid diseases. EYE and ALBUMIN reveal such patients did not have these screening services in the base year. At least some patients in these clusters had A1C testing and LIPID testing in the base year of this study. Finally, RESULTIP indicates patients in these prominent clusters are not admitted to the hospital for inpatient acute care in the follow-up period.
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</table>

Figure 4.4 Self-Organizing Map for Follow-up Period Inpatient Admissions
**Health Outcomes**

The findings in this section relate to the research hypothesis that health-screening services delivered in the base year of the study improve health outcomes in the follow-up period by delaying the onset of co-morbid disease. Findings are presented in two sections including presence of microvascular disease and macrovascular disease in the follow-up period.

**Follow-up period Presence of Microvascular Disease:** The unified distance matrix (U-matrix) is shown in Figure 4.5 Self-Organizing Map for Follow-up period Microvascular Disease. This graphic displays mathematical proximity of each neuron to its neighboring neurons. The ‘closer’ a neuron is to its neighboring neurons the darker the color reflecting the shorter distance to these neighboring neurons. Darkened areas on the U-matrix therefore indicate clusters of similar patient characteristics.

This outcome variable identified as MICCHNG on the component map is a dichotomous variable indicating if the patient demonstrated claim evidence of microvascular disease in the follow-up period. Microvascular disease is defined by evidence of nephropathy or end stage renal disease, retinopathy or blindness and neuropathy or amputation. Patients with microvascular disease at the end of the base year are removed from this analysis.

Prominent clusters occur throughout the U-matrix map. A review of the individual components used to build this U-matrix describes the characteristics of these clusters. These individual components are also provided in Figure 4.5 Self-Organizing Map for Follow-up period Microvascular Disease.

A demarcation line exists on the U-matrix that separates prominent clusters. The top portion of the U-matrix can be generalized as younger patients by a review of the component
AGE. The SEX component reveals clusters of both male and female patients while the DEPFLAG component shows few occurrences of major depressive disorder in these clusters. CHRBRVS, TOTRBRVS and VISITS indicate low use of professional services in the base year of this study by these patients in the upper prominent clusters. With the removal of MICFLAG (all these patients did not have microvascular disease at the end of the base year of this study) CHFLAG and MACFLAG are identical. In the upper portion of the U-matrix these components indicate patients lack evidence of macrovascular disease in the follow-up period. While EYE indicates these patients did not have eye examinations in the base year, A1C, LI PID and ALBUMIN do show signs patients in these clusters had these services performed in the base year. Finally, the MICCHNG component indicating evidence of microvascular disease in the follow-up period shows some patients in these prominent upper half clusters did develop microvascular disease in the follow-up period.

Patient clusters below the demarcation line are characterized by the AGE component as middle aged to elderly and by SEX as having clusters of both males and females. Some patients have evidence of major depressive disorders in the base year as shown by the DEPFLAG component. CHRBRVS, TOTRBRVS and VISITS show patients in these lower half clusters have higher than average levels of the use of professional services in the base year. MACFLAG and CHFLAG as identical components show these patient clusters do have evidence of macrovascular disease in the base year. EYE and ALBUMIN components indicate these patients are not screened for these services in the base year. A1C and LI PID components reveal patients in these lower half clusters did have such screening services. The MICCHNG component shows some patients located on the U-matrix map did develop microvascular disease in the follow-up period.
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*Figure 4.5 Self-Organizing Map for Follow-up Period Microvascular Disease*
Follow-up period Presence of Macrovascular Disease: The unified distance matrix (U-matrix) is shown in Figure 4.6 Self-Organizing Map for Follow-up period Macrovascular Disease. This outcome variable identified as MACCHNG on the component map is a dichotomous variable indicating if the patient demonstrated claim evidence of macrovascular disease in the follow-up period. Macrovascular disease is defined by evidence of hypertension, dyslipidemia, cardiovascular disease or stroke. Patients with evidence of macrovascular disease at the end of the base year are removed from this analysis.

Prominent clusters are less defined in this map as compared to the presence of microvascular disease. All but one cluster exists on the right hand side of the U-matrix. A review of the individual components used to build this U-matrix describes the characteristics of these clusters. These individual components are also provided in Figure 4.6 Self-Organizing Map for Follow-up period Macrovascular Disease.

AGE, SEX and DEPFLAG indicate a mix of these characteristics in prominent clusters. CHRVBRS, TOTRBRVS and VISITS reveal low levels of professional service use in the base year of this study by patients in these right-hand side clusters. All patients in this cluster analysis had no evidence of macrovascular disease at the end of the base year so CHFLAG and MICFLAG are identical. These components demonstrate patients in these clusters did not have evidence of microvascular disease in the base year. All four screening service components, EYE, A1C, LIPID and ALBUMIN show clusters in which such services are performed in the base year. Finally, MACCHNG shows many of these patients did develop macrovascular disease in the follow-up period.
**COMPONET** | **VARIABLE DESCRIPTION** | **VARIABLE STATUS**
--- | --- | ---
AGE | Patient Age at end of Base year (7/31/2001) | Continuous Covariate
SEX | Patient Gender (1=Male, 0=Female) | Dichotomous Covariate
DEPFLAG | Base year Depression Flag (1=Yes, 0=No) | Dichotomous Covariate
CHRBRVS | Base year Sum of Rbrvs for Co-Morbid Services | Continuous Covariate
TOTRBRVS | Base year Sum of Rbrvs for All Professional Services | Continuous Covariate
CHFLAG | Base year Flag for Any Co-Morbid Disease | Dichotomous Covariate
MACFLAG | Base year Flag for Macrovascular Co-Morbid Disease | Dichotomous Covariate
MICFLAG | Base year Flag for Microvascular Co-Morbid Disease | Dichotomous Covariate
VISITS | Base year Number of Professional Visits | Continuous Covariate
EYE | Base year Indicator for Eye Exam (1=Yes, 0=No) | Dichotomous Independent
A1C | Base year Indicator for A1C Testing (1=Yes, 0=No) | Dichotomous Independent
LIPID | Base year Indicator for Lipids Testing (1=Yes, 0=No) | Dichotomous Independent
ALBUMIN | Base year Indicator for Albumin Testing (1=Yes, 0=No) | Dichotomous Independent
MACCHNG | Follow-up period Macrovascular Disease (1=Yes, 0=No) | Dichotomous Dependent

*Figure 4.6 Self-Organizing Map for Follow-up Period Macrovascular Disease*
**Exploratory Cluster Analysis Summary**

This exploratory analysis reviews the most prominent clusters using self-organizing maps. A summary of this cluster analysis is shown in Table 4.1 Summary of Cluster Analysis Findings.

<table>
<thead>
<tr>
<th>Costs</th>
<th>Outcome Variable</th>
<th>Patient Characteristics at Base Year</th>
<th>Prominent Clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follow-up period Costs</td>
<td>-Young</td>
<td>-No Co-Morbid Disease</td>
<td>Low Follow-up Period Costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-A1C Testing</td>
<td></td>
</tr>
<tr>
<td>Follow-up period Costs Change</td>
<td>N/A</td>
<td></td>
<td>None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Utilization</th>
<th>Outcome Variable</th>
<th>Patient Characteristics at Base Year</th>
<th>Prominent Clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follow-up period ED Utilization</td>
<td>-Young</td>
<td>-No Co-Morbid Disease</td>
<td>No Follow-up Period ED Utilization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-A1C &amp; Lipids Testing</td>
<td></td>
</tr>
<tr>
<td>Follow-up period Inpatient Admission</td>
<td>-Young</td>
<td>-No Co-Morbid Disease</td>
<td>No Follow-up Period Inpatient Admissions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-A1C &amp; Lipids Testing</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Health Outcomes</th>
<th>Outcome Variable</th>
<th>Patient Characteristics at Base Year</th>
<th>Prominent Clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follow-up period Presence of Microvascular Disease</td>
<td>-Young</td>
<td>-No Co-Morbid Disease</td>
<td>No Follow-up Period Microvascular Disease</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-A1C &amp; Lipids Screening</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Older</td>
<td>-Co-Morbid Disease</td>
<td>No Follow-up Period Microvascular Disease</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-A1C &amp; Lipids Screening</td>
<td></td>
</tr>
<tr>
<td>Follow-up period Presence of Macrovascular Disease</td>
<td>-All Ages</td>
<td>-No Co-Morbid Disease</td>
<td>Follow-up Period Macrovascular Disease</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-All Screening Services</td>
<td></td>
</tr>
</tbody>
</table>

*Table 4.1 Summary of Cluster Analysis Findings*

**Costs:** Data clusters do exist in the analysis of follow-up period costs. Patients in these clusters are young and free of co-morbid disease at the end of the base year. Some clusters are associated with screening services for A1C testing but not for eye exams, lipids testing or
albumin testing. Patients in these clusters have low follow-up period costs. No data clusters are observed in the analysis of follow-up period costs changes.

The first research hypothesis states base year screening services are associated with reduced costs for Type 2 diabetics in the follow-up period. The presence of clusters for younger patients without co-morbid disease and few screening services provides inconclusive evidence related to this research hypothesis. Additional statistical analysis is necessary to define any associations between base year health-screening services and follow-up period costs.

**Utilization:** Data clusters do exist in the analysis of follow-up period utilization of acute care services. Patients in these clusters are young and free of co-morbid disease at the end of the base year. The screening services provided for patients in these clusters include A1C testing and lipids testing, but not eye exams or albumin testing. Patients in these clusters have low follow-up period utilization of acute care services.

The second research hypothesis states base year screening services are associated with reduced utilization for Type 2 diabetics in the follow-up period. The presence of clusters for younger patients without co-morbid disease and few screening services also provides inconclusive evidence related to this research hypothesis. Additional statistical analysis is necessary to define any associations between base year health-screening services and follow-up period utilization.

**Health Outcomes:** Data clusters are very prominent and numerous in the analysis of follow-up period microvascular disease. Patient clusters include young persons free of co-morbid disease as well as older persons with co-morbid disease. In both instances base year screening services extend beyond A1C testing to include lipids testing. These clusters are associated with the lack of microvascular disease in the follow-up period. Further, analysis of macrovascular
disease shows clusters of patients of all ages with all screening services and the presence of macrovascular disease in the follow-up period.

The third research hypothesis states base year screening services are associated with improved health by delaying the onset of co-morbid disease for Type 2 diabetics in the follow-up period. The presence of clusters associated with screening services such as A1C testing and lipids testing and the absence of follow-up period microvascular disease provide preliminary evidence to confirm this research hypothesis. Clusters in which all screenings are associated with presence of follow-up period macrovascular disease raise additional research questions. Statistical analysis of the individual components of microvascular and macrovascular disease are necessary to provide insights into preliminary evidence such health-screening services are associated with improved follow-up period health outcomes for Type 2 diabetic patients.
STATISTICAL ANALYSIS

Statistical analysis is focused and searches to quantify observed relationships identified in the cluster analysis of this study. The technique described in Chapter 3 of this thesis and used in this statistical section of these findings are bivariate correlations and regression. Linear regression is used in the analysis of continuous outcome variables. Logistical regression is used in the analysis of dichotomous outcome variables. Findings in this section are presented for costs, utilization and health outcomes. A summary of statistical analysis is presented at the end of this section.

Costs

The findings in this section relate to the research hypothesis that health-screening services delivered in the base year of the study reduce costs for Type 2 diabetics in the follow-up period. Findings are presented in two statistical sections including follow-up period costs (sum of medical and pharmaceutical claims) and follow-up period cost changes (percentage increase in follow-up period total costs over the base year). This analysis includes follow-up period costs for all patients with both medical and pharmaceutical claims in the base year of this study.

Follow-up period Costs. The study population (2632 patients) incurred $12,425,362.57 in total health expenditures in the base year (12 months) of this study. Within the follow-up period (up to 24 months following the base year) these same patients generate $32,385,141.56 in direct medical costs. Figure 4.7 Claims per Patient Month, shows claims for this study population increase from an average of $393.41 for each patient each month in the base year of the study to an average of $512.68 for each patient each month in the follow-up period of this
study. This increase in direct health care costs (30.1% in 2 years) represents a rate of increase nearly twice the national health care inflationary rate for direct health care expenditures (Heffler, 2004).

![Claims Costs Per Patient Per Month](image)

**Figure 4.7 Claims Costs per Patient Month**

All covariates exhibit positive correlations with the dependent variable of follow-up period Costs as shown in Table 4.2, Bivariate Correlations with Follow-up period Costs. Statistically significant (p < 0.05 and highlighted) covariates include base year count of professional visits (VISITS), base year sum of Rbrvs for all professional visits (TOTBRVS), base year sum of Rbrvs for co-morbid services (CHRBRVS), base year flag for microvascular co-morbid disease (MICFLAG), base year flag for any co-morbid disease (CHFLAG), and base year flag for macrovascular co-morbid disease (MACFLAG).
<table>
<thead>
<tr>
<th>Covariate Variable</th>
<th>Covariate Description</th>
<th>Correlation Coefficient</th>
<th>Significance p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>*VISITS</td>
<td>Base year Count of Professional Visits</td>
<td>+ 0.156</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>TOTRBRVS</td>
<td>Base year Sum of Rbrvs for All Professional Services</td>
<td>+ 0.138</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>CHRBRVS</td>
<td>Base year Sum of Rbrvs for Co-Morbid Services</td>
<td>+ 0.088</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>MICFLAG</td>
<td>Base year Flag for Microvascular Co-Morbid Disease</td>
<td>+ 0.077</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>CHFLAG</td>
<td>Base year Flag for Any Co-Morbid Disease</td>
<td>+ 0.068</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>MACFLAG</td>
<td>Base year Flag for Macrovascular Co-Morbid Disease</td>
<td>+ 0.046</td>
<td>0.019</td>
</tr>
<tr>
<td>DEPFLAG</td>
<td>Base year Depression Flag (1=Yes, 0=No)</td>
<td>+ 0.016</td>
<td>0.426</td>
</tr>
<tr>
<td>SEX</td>
<td>Patient Gender (1=Male, 0=Female)</td>
<td>+ 0.008</td>
<td>0.697</td>
</tr>
<tr>
<td>AGE</td>
<td>Patient Age at end of Base year (7/31/2001)</td>
<td>+ 0.002</td>
<td>0.907</td>
</tr>
</tbody>
</table>

Table 4.2 Bivariate Correlations with Follow-up Period Costs

Base year count of professional visits (VISITS) is the significant covariates used to build the baseline linear regression model. The significant variable used to build this baseline linear regression model is marked with an asterisk in Table 4.2 Bivariate Correlations with Follow-up period Costs. This baseline model has an r-squared value of 0.024.

Each combination of screening services delivered in the base year of this study is presented independently as additions to this baseline linear regression model. Table 4.3 Combinations of Screening Services for Follow-up period Costs documents regression coefficients and significance level for each of these screening services and combinations of screening services entered into this baseline linear regression model. Statistically significant models are highlighted in gray, representing both overall model contribution significance and statistically significant regression coefficients of these independent variable additions. Significant positive correlation coefficients are observed for all base year screening services as well as several combinations of base year screening services.
<table>
<thead>
<tr>
<th>Baseline Regression Model (VISITS) + Screening Services</th>
<th>Un-Standardized Coefficient</th>
<th>Coefficient Significance p-value</th>
<th>Model Significance p-value</th>
<th>Model Adjusted R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Year Eye</td>
<td>+1753.93</td>
<td>0.027</td>
<td>&lt;0.0005</td>
<td>0.025</td>
</tr>
<tr>
<td>Base Year A1C</td>
<td>+4255.36</td>
<td>&lt;0.0005</td>
<td>&lt;0.0005</td>
<td>0.034</td>
</tr>
<tr>
<td>Base Year Lipids</td>
<td>+3752.33</td>
<td>&lt;0.0005</td>
<td>&lt;0.0005</td>
<td>0.032</td>
</tr>
<tr>
<td>Base Year Albumin</td>
<td>+5063.29</td>
<td>&lt;0.0005</td>
<td>&lt;0.0005</td>
<td>0.034</td>
</tr>
<tr>
<td>Base Year Eye + A1C</td>
<td>+1691.65</td>
<td>0.032</td>
<td>&lt;0.0005</td>
<td>0.036</td>
</tr>
<tr>
<td>+ Lipids</td>
<td>+4230.90</td>
<td>&lt;0.0005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Year Eye + Lipids</td>
<td>+1659.48</td>
<td>0.036</td>
<td>&lt;0.0005</td>
<td>0.034</td>
</tr>
<tr>
<td>+ Albumin</td>
<td>+3713.14</td>
<td>&lt;0.0005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids</td>
<td>+1633.70</td>
<td>0.039</td>
<td>&lt;0.0005</td>
<td>0.035</td>
</tr>
<tr>
<td>+ Albumin</td>
<td>+5003.81</td>
<td>&lt;0.0005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Year A1C + Lipids</td>
<td>+3081.39</td>
<td>0.01</td>
<td>&lt;0.0005</td>
<td>0.036</td>
</tr>
<tr>
<td>+ Albumin</td>
<td>+2194.33</td>
<td>0.014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Year A1C + Lipids + Albumin</td>
<td>+3332.27</td>
<td>&lt;0.0005</td>
<td>&lt;0.0005</td>
<td>0.039</td>
</tr>
<tr>
<td>Base Year Lipids + Albumin</td>
<td>+2797.87</td>
<td>&lt;0.0005</td>
<td>&lt;0.0005</td>
<td>0.038</td>
</tr>
<tr>
<td>+ Albumin</td>
<td>+3963.49</td>
<td>&lt;0.0005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids + Albumin</td>
<td>+1653.76</td>
<td>0.036</td>
<td>&lt;0.0005</td>
<td>0.038</td>
</tr>
<tr>
<td>+ A1C</td>
<td>+3077.25</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ Lipids</td>
<td>+2157.37</td>
<td>0.015</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids + Albumin</td>
<td>+1614.53</td>
<td>0.040</td>
<td>&lt;0.0005</td>
<td>0.040</td>
</tr>
<tr>
<td>+ A1C</td>
<td>+3322.23</td>
<td>&lt;0.0005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ Lipids</td>
<td>+3766.58</td>
<td>&lt;0.0005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Year Eye + Lipids + Albumin</td>
<td>+1589.33</td>
<td>0.044</td>
<td>&lt;0.0005</td>
<td>0.039</td>
</tr>
<tr>
<td>+ A1C</td>
<td>+2771.81</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ Albumin</td>
<td>+3915.87</td>
<td>&lt;0.0005</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Year A1C + Lipids + Albumin</td>
<td>+2544.52</td>
<td>0.006</td>
<td>&lt;0.0005</td>
<td>0.040</td>
</tr>
<tr>
<td>+ A1C</td>
<td>+1629.00</td>
<td>0.071</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ Albumin</td>
<td>+3474.82</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids + Albumin</td>
<td>+1593.36</td>
<td>0.043</td>
<td>&lt;0.0005</td>
<td>0.041</td>
</tr>
<tr>
<td>+ A1C</td>
<td>+2548.01</td>
<td>0.006</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ Lipids</td>
<td>+1601.27</td>
<td>0.076</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ Albumin</td>
<td>+3426.40</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 4.3 Combinations of Screening Services for Follow-up Period Costs*
Follow-up period Cost Changes: The study population’s direct health costs increased on average at an annual rate greater than fourteen percent. During this same time U.S. health expenditures increased 7.3% in 2001 and at a rate of 9.3% in 2002 (Heffler, 2004). This study analyzes patients with high (greater than the national direct health care inflationary rate) and low levels of increase in direct health costs from the base year of this study.

Of 2632 participants in this study, 50.4% (1327 patients) have follow-up period direct health cost changes less than or equal to the national rate of health care inflation compared to the base year of this study. 49.6% (1305 patients) of these study participants have direct health costs that increased from the base year of this study at a rate greater than this national rate of increase for direct health expenditures.

<table>
<thead>
<tr>
<th>Covariate Variable</th>
<th>Covariate Description</th>
<th>Correlation Coefficient</th>
<th>Significance p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTRBRVS</td>
<td>Base year Sum of Rbrvs for All Professional Services</td>
<td>-0.157</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>VISITS</td>
<td>Base year Count of Professional Visits</td>
<td>-0.141</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHRBRVS</td>
<td>Base year Sum of Rbrvs for Co-Morbid Services</td>
<td>-0.106</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHFLAG</td>
<td>Base year Flag for Any Co-Morbid Disease</td>
<td>-0.071</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>MACFLAG</td>
<td>Base year Flag for Macrovascular Co-Morbid Disease</td>
<td>-0.068</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>AGE</td>
<td>Patient Age at end of Base year (7/31/2001)</td>
<td>-0.042</td>
<td>0.031</td>
</tr>
<tr>
<td>SEX</td>
<td>Patient Gender (1=Male, 0=Female)</td>
<td>+0.034</td>
<td>0.078</td>
</tr>
<tr>
<td>MICFLAG</td>
<td>Base year Flag for Microvascular Co-Morbid Disease</td>
<td>-0.025</td>
<td>0.194</td>
</tr>
<tr>
<td>DEPFLAG</td>
<td>Base year Depression Flag (1=Yes, 0=No)</td>
<td>-0.007</td>
<td>0.728</td>
</tr>
</tbody>
</table>

Table 4.4 Bivariate Correlations with Follow-up Period Costs Changes

Table 4.4 Bivariate Correlations with Follow-up period Costs Changes list study covariates correlation coefficients and significance as related to the dependent variable in this analysis, follow-up period costs changes. Statistically significant (p < 0.05 and highlighted)
covariates include age (AGE), base year sum of Rbrvs for co-morbid services (CHRBRVS), base year sum of Rbrvs for all professional services (TOTRBRVS), base year flag for any co-morbid disease (CHFLAG), base year flag for macrovascular co-morbid disease (MACFLAG) and the base year number of professional visits (VISITS). Each of these covariates exhibit negative correlation coefficients in relation to the dependent variable.

The base year sum of Rbrvs for all professional services (TOTRBRVS) is the significant covariate used to build the baseline logistic regression model. Significant variables used to build this baseline logistic regression model are marked with an asterisk in Table 4.4 Bivariate Correlations with Follow-up period Costs Changes. This baseline model has an estimated r-squared value between 0.028 and 0.307.

Screening services delivered in the base year of this study are presented independently as additions to this baseline logistic regression model. Table 4.5 Screening Services for Follow-up period Cost Changes documents regression coefficients and significance level for each of these screening services and combinations of screening services entered into the baseline logistic regression model. Statistically significant models are highlighted in gray, representing both overall contributions to model significance and statistically significant regression coefficients of these independent variable additions. A significant positive regression coefficient is observed for base year screening services for albumin testing and follow-up period costs changes.

<table>
<thead>
<tr>
<th>Baseline Regression Model (TOTRBRVS) + Screening Services</th>
<th>Beta Coefficient (Sig.)</th>
<th>Odds Ratio</th>
<th>Estimated R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Year Eye</td>
<td>+ 0.003 (0.971)</td>
<td>1.003</td>
<td>0.028 – 0.037</td>
</tr>
<tr>
<td>Base Year A1C</td>
<td>+ 0.057 (0.482)</td>
<td>1.059</td>
<td>0.028 – 0.037</td>
</tr>
<tr>
<td>Base Year Lipids</td>
<td>+ 0.077 (0.331)</td>
<td>1.080</td>
<td>0.028 – 0.037</td>
</tr>
<tr>
<td>Base Year Albumin</td>
<td>+ 0.216 (0.033)</td>
<td>1.241</td>
<td>0.029 – 0.039</td>
</tr>
</tbody>
</table>

Table 4.5 Screening Services for Follow-up Period Cost Changes
Utilization

The findings in this section relate to the research hypothesis that health-screening services delivered in the base year of the study reduce acute care utilization for Type 2 diabetic patients in the follow-up period. Findings are presented in two statistical sections including follow-up period utilization of the Emergency Department (ED) and follow-up period admissions for acute inpatient care. A total of 3897 patients are included in this analysis. This study is based on the random selection (approximately 50% of study population) of 1944 patients from the study population. The remaining 1953 patients are set aside to provide a validation dataset for significant findings related to utilization.

Follow-up period ED Utilization: The randomly selected study population (1944 patients) includes 30 patients (1.5%) who visited the Emergency Department (ED) in the base year for 34 visits. During the 2 year follow-up period of this study this same population include 565 patients (29.1%) has 1114 Emergency Department visits. The annual rates of Emergency Department utilization per 1000 patients are presented in Figure 4.8 Study Population’s Change in Emergency Department Utilization. The annual rate of ED utilization for this study population is fifteen times greater in the follow-up period compared to the first twelve months of this study.
Several covariate factors are positively correlated to the number of ED visits in the follow-up period. Statistically significant (p < 0.05 and highlighted) covariates as listed in Table 4.6 Bivariate Correlations with Follow-up period ED Utilization include the base year sum of Rbrvs for co-morbid professional services (CHRBRVS), base year sum of Rbrvs for all total professional services (TOTRBRVS), base year flag for any co-morbid disease (CHFLAG), base year flag for any macrovascular co-morbid disease (MACFLAG), base year flag for any microvascular co-morbid disease (MICFLAG), and base year count of visits for professional services (VISITS). Each of these covariates exhibits positive correlation coefficients in relation to the dependent variable.
<table>
<thead>
<tr>
<th>Covariate Variable</th>
<th>Covariate Description</th>
<th>Correlation Coefficient</th>
<th>Significance p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>*TOTRBRVS</td>
<td>Base Year Sum of Rbrvs for All Professional Services</td>
<td>+ 0.428</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>VISITS</td>
<td>Base Year Count of Visits for Professional Services</td>
<td>+ 0.393</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHRBRVS</td>
<td>Base Year Sum of Rbrvs for Co-Morbid Professional Services</td>
<td>+ 0.182</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>AGE</td>
<td>Patient Age 7/31/2001</td>
<td>+ 0.127</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>MACFLAG</td>
<td>Base Year Flag for Any Macrovascular Co-Morbid Disease</td>
<td>+ 0.102</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>MICFLAG</td>
<td>Base Year Flag for Any Microvascular Co-Morbid Disease</td>
<td>+ 0.100</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHFLAG</td>
<td>Base Year Flag for Any Co-Morbid Disease</td>
<td>+ 0.088</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>SEX</td>
<td>Patient Gender (1=Male, 0=Female)</td>
<td>- 0.028</td>
<td>0.212</td>
</tr>
<tr>
<td>DEPFLAG</td>
<td>Depression Flag (1=Yes, 0=No)</td>
<td>+ 0.010</td>
<td>0.654</td>
</tr>
</tbody>
</table>

*Table 4.6 Bivariate Correlations with Follow-Up Period ED Utilization*

The base year count sum of Rbrvs for all professional services (TOTRBRVS) is the significant covariate used to build the baseline linear regression model. Significant variables used to build this baseline linear regression model are marked with an asterisk in Table 4.6 Bivariate Correlations with Follow-up period ED Utilization. This baseline model has an r-squared value of 0.183.

Each combination of screening services delivered in the base year of this study is presented independently as additions to this baseline linear regression model. Table 4.7 Combinations of Screening Services for Follow-up period ED Utilization documents regression coefficients and significance level for each of these screening services and combinations of screening services entered into the baseline linear regression model. Statistically significant models are highlighted in gray, representing both overall contributions to model significance and statistically significant regression coefficients of these independent variable additions. A
significant negative regression coefficient is observed for base year screening services for lipids testing and follow-up period ED utilization.

<table>
<thead>
<tr>
<th>Baseline Regression Model</th>
<th>Un-Standardized Coefficient</th>
<th>Coefficient Significance p-value</th>
<th>Model Significance p-value</th>
<th>Model Adjusted R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>(TOTRBRVS) + Screening Service(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Year Eye</td>
<td>+ 0.135</td>
<td>0.063</td>
<td>&lt; 0.0005</td>
<td>0.184</td>
</tr>
<tr>
<td>Base Year A1C</td>
<td>- 0.126</td>
<td>0.081</td>
<td>&lt; 0.0005</td>
<td>0.183</td>
</tr>
<tr>
<td>Base Year Lipids</td>
<td>- 0.188</td>
<td>0.013</td>
<td>&lt; 0.0005</td>
<td>0.185</td>
</tr>
<tr>
<td>Base Year Albumin</td>
<td>- 0.065</td>
<td>0.524</td>
<td>&lt; 0.0005</td>
<td>0.182</td>
</tr>
<tr>
<td>Base Year Eye + A1C</td>
<td>+ 0.130</td>
<td>0.075</td>
<td>&lt; 0.0005</td>
<td>0.184</td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids</td>
<td>+ 0.129</td>
<td>0.076</td>
<td>&lt; 0.0005</td>
<td>0.186</td>
</tr>
<tr>
<td>Base Year Eye + Albumin</td>
<td>+ 0.135</td>
<td>0.063</td>
<td>&lt; 0.0005</td>
<td>0.183</td>
</tr>
<tr>
<td>Base Year A1C + Lipids</td>
<td>- 0.026</td>
<td>0.777</td>
<td>&lt; 0.0005</td>
<td>0.184</td>
</tr>
<tr>
<td>Base Year A1C + Albumin</td>
<td>- 0.126</td>
<td>0.104</td>
<td>&lt; 0.0005</td>
<td>0.183</td>
</tr>
<tr>
<td>Base Year Lipids + Albumin</td>
<td>- 0.197</td>
<td>0.015</td>
<td>&lt; 0.0005</td>
<td>0.184</td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids + Albumin</td>
<td>+ 0.128</td>
<td>0.077</td>
<td>&lt; 0.0005</td>
<td>0.185</td>
</tr>
<tr>
<td>Base Year Eye + A1C + Albumin</td>
<td>+ 0.130</td>
<td>0.075</td>
<td>&lt; 0.0005</td>
<td>0.184</td>
</tr>
<tr>
<td>Base Year Eye + Lipids</td>
<td>+ 0.129</td>
<td>0.077</td>
<td>&lt; 0.0005</td>
<td>0.185</td>
</tr>
<tr>
<td>Base Year Eye + Albumin</td>
<td>+ 0.002</td>
<td>0.794</td>
<td>&lt; 0.0005</td>
<td>0.185</td>
</tr>
<tr>
<td>Base Year A1C + Lipids + Albumin</td>
<td>- 0.033</td>
<td>0.725</td>
<td>&lt; 0.0005</td>
<td>0.184</td>
</tr>
<tr>
<td>Base Year A1C + Lipids + Albumin</td>
<td>- 0.033</td>
<td>0.725</td>
<td>&lt; 0.0005</td>
<td>0.184</td>
</tr>
<tr>
<td>Base Year A1C + Lipids + Albumin</td>
<td>- 0.033</td>
<td>0.725</td>
<td>&lt; 0.0005</td>
<td>0.184</td>
</tr>
</tbody>
</table>

*Table 4.7 Combinations of Screening Services for Follow-up Period ED Utilization*

The constant for this model is insignificant. The linear regression model for predicting follow-up period emergency department utilization is $Y_1 = 0.041\times TOTRBRVS - 0.188\times LIPID$. 

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**Follow-up period Inpatient Admissions:** The randomly selected study population (1944 patients) has 22 inpatient admissions by 14 individual patients in the base year of this study. In the follow-up period of the study 365 patients are admitted for acute care inpatient services resulting in 688 inpatient admissions. This change in the use of acute care inpatient services is shown graphically in Figure 4.9 Study Population’s Change in Acute Inpatient Utilization.

![Acute Inpatient Annual Utilization per 1000 Patients](image)

*Figure 4.9 Study Population’s Change in Acute Inpatient Utilization*

Several covariate factors are positively correlated to the number of acute inpatient admissions in the follow-up period. Statistically significant (p < 0.05 and highlighted) covariates are listed in Table 4.8 Bivariate Correlations with Follow-up period Acute Inpatient Utilization. The significant positive correlates include age (AGE), gender (SEX), base year sum of Rbrvs for co-morbid professional services (CHRBRVS), base year sum of Rbrvs for all professional services (TOTRBRVS), base year flag for any co-morbid disease (CHFLAG), base year flag for
any macrovascular co-morbid disease (MACFLAG), base year flag for any microvascular co-
morbid disease (MICFLAG) and base year count of visits for professional services (VISITS).

<table>
<thead>
<tr>
<th>Covariate Variable</th>
<th>Covariate Description</th>
<th>Correlation Coefficient</th>
<th>Significance p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>*VISITS</td>
<td>Base Year Count of Visits for Professional Services</td>
<td>+ 0.305</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>TOTRBRVS</td>
<td>Base Year Sum of Rbrvs for All Professional Services</td>
<td>+ 0.270</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>AGE</td>
<td>Patient Age 7/31/2001</td>
<td>+ 0.254</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHRBRVS</td>
<td>Base Year Sum of Rbrvs for Co-Morbid Professional Services</td>
<td>+ 0.190</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>MACFLAG</td>
<td>Base Year Flag for Any Macrovascular Co-Morbid Disease</td>
<td>+ 0.122</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>MICFLAG</td>
<td>Base Year Flag for Any Microvascular Co-Morbid Disease</td>
<td>+ 0.122</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHFLAG</td>
<td>Base Year Flag for Any Co-Morbid Disease</td>
<td>+ 0.116</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>SEX</td>
<td>Patient Gender (1=Male, 0=Female)</td>
<td>- 0.046</td>
<td>0.044</td>
</tr>
<tr>
<td>DEPFLAG</td>
<td>Depression Flag (1=Yes, 0=No)</td>
<td>+ 0.007</td>
<td>0.747</td>
</tr>
</tbody>
</table>

*Table 4.8 Bivariate Correlations with Follow-up Period Acute Inpatient Utilization*

The base year count of visits for professional services (VISITS) is the significant covariate used to build the baseline linear regression model and is shown with an asterisk in Table 4.8 Bivariate Correlations with Follow-up period Acute Inpatient Utilization. This baseline model has an r-squared value of 0.093.

Each combination of screening services delivered in the base year of this study is presented independently as additions to this baseline linear regression model. Table 4.9 Combinations of Screening Services for Follow-up period Acute Inpatient Utilization documents regression coefficients and significance level for each of these screening services and combinations of screening services entered into the baseline linear regression model. Statistically significant models are highlighted in gray, representing both overall contributions to model significance and statistically significant regression coefficients of these independent variable
additions. A significant negative regression coefficient is observed for base year screening services for A1C, lipids and albumin testing and follow-up period Acute Inpatient utilization.

<table>
<thead>
<tr>
<th>Baseline Regression Model (VISITS) + Screening Services</th>
<th>Un-Standardized Coefficient</th>
<th>Coefficient Significance</th>
<th>Model Significance</th>
<th>Model Adjusted R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Year Eye</td>
<td>+ 0.063</td>
<td>0.165</td>
<td>&lt; 0.0005</td>
<td>0.093</td>
</tr>
<tr>
<td>Base Year A1C</td>
<td>- 0.236</td>
<td>&lt; 0.0005</td>
<td>&lt; 0.0005</td>
<td>0.105</td>
</tr>
<tr>
<td>Base Year Lipids</td>
<td>- 0.223</td>
<td>&lt; 0.0005</td>
<td>&lt; 0.0005</td>
<td>0.103</td>
</tr>
<tr>
<td>Base Year Albumin</td>
<td>- 0.169</td>
<td>0.008</td>
<td>&lt; 0.0005</td>
<td>0.095</td>
</tr>
<tr>
<td>Base Year Eye + A1C</td>
<td>+ 0.053</td>
<td>0.240</td>
<td>&lt; 0.0005</td>
<td>0.105</td>
</tr>
<tr>
<td>Base Year Eye + Lipids</td>
<td>+ 0.056</td>
<td>0.214</td>
<td>&lt; 0.0005</td>
<td>0.103</td>
</tr>
<tr>
<td>Base Year Eye + Albumin</td>
<td>+ 0.064</td>
<td>0.158</td>
<td>&lt; 0.0005</td>
<td>0.096</td>
</tr>
<tr>
<td>Base Year A1C + Lipids</td>
<td>- 0.221</td>
<td>&lt; 0.0005</td>
<td>0.007</td>
<td>0.106</td>
</tr>
<tr>
<td>Base Year A1C + Albumin</td>
<td>- 0.221</td>
<td>&lt; 0.0005</td>
<td>0.425</td>
<td>0.105</td>
</tr>
<tr>
<td>Base Year Lipids + Albumin</td>
<td>- 0.204</td>
<td>&lt; 0.0005</td>
<td>0.306</td>
<td>0.103</td>
</tr>
<tr>
<td>Base Year A1C + Lipids + Albumin</td>
<td>+ 0.053</td>
<td>0.246</td>
<td>&lt; 0.0005</td>
<td>0.106</td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids</td>
<td>+ 0.054</td>
<td>0.232</td>
<td>&lt; 0.0005</td>
<td>0.105</td>
</tr>
<tr>
<td>Base Year Eye + A1C + Albumin</td>
<td>+ 0.057</td>
<td>0.206</td>
<td>&lt; 0.0005</td>
<td>0.103</td>
</tr>
<tr>
<td>Base Year A1C + Lipids + Albumin</td>
<td>- 0.163</td>
<td>0.005</td>
<td>&lt; 0.0005</td>
<td>0.106</td>
</tr>
<tr>
<td>Base Year A1C + Lipids + Albumin</td>
<td>- 0.111</td>
<td>0.065</td>
<td>&lt; 0.0005</td>
<td>0.106</td>
</tr>
<tr>
<td>Base Year A1C + Lipids + Albumin</td>
<td>- 0.030</td>
<td>0.663</td>
<td>&lt; 0.0005</td>
<td>0.106</td>
</tr>
</tbody>
</table>

Table 4.9 Combinations of Screening Services for Follow-up period Acute Inpatient Utilization

Three valid statistical models are derived from this analysis. Follow-up period acute inpatient utilization is modeled by \( Y_2 = 0.170 + (0.034 \times \text{VISITS}) - (0.236 \times \text{A1C}) \). Another model for predicting follow-up period acute care utilization is \( Y_3 = 0.125 + (0.035 \times \text{VISITS}) - \)
LIPID). The final model for this dependent variable does not include a constant which is insignificant. This model is \( Y_4 = (0.037 * \text{VISITS}) - (0.169 * \text{ALBUMIN}) \).

**Health Outcomes**

The findings in this section relate to the research hypothesis that health-screening services delivered in the base year of the study improve healthy outcomes by delaying the onset of co-morbid disease in the follow-up period. Findings are presented in two statistical sections including microvascular diseases of nephropathy, retinopathy, and neuropathy and macrovascular diseases of hypertension, dyslipidemia, cardiovascular disease and stroke. A total of 3897 patients are included in this analysis. This study is based on the random selection (approximately 50% of study population) of 1944 patients from the study population. The remaining 1953 patients are set aside to provide a validation dataset for significant findings related to health outcomes.

**Follow-up period Presence of Nephropathy:** Several prominent clusters related to the presence of follow-up period microvascular disease are observed in this study. The findings in this section relate to the microvascular disease of nephropathy.

In the base year of this study 1.8% of the randomly selected study population has claim evidence of nephropathy (35 of 1944 patients). An additional 75 patients have claim evidence of this disease by the end of this study (for a total 110 of 1944 patients by the end of this study). This change in the percentage of the study population with this co-morbid disease is shown graphically in Figure 4.10 Study Population’s Change in Nephropathy.
Figure 4.10 Study Population’s Change in Nephropathy

During this study an average of 3.5 Type 2 diabetic patients per month are first diagnosed with nephropathy. The number of patients first diagnosed with nephropathy by month is presented in Figure 4.11 Study Population’s First Nephropathy Diagnosis by Month.

Figure 4.11 Study Population’s First Nephropathy Diagnosis by Month
Statistical analysis is based on the 1909 patients without claim evidence of nephropathy by the end of the base year of this study (35 patients excluded from the random sample of 1944 patients). Several covariate factors are positively correlated to the presence of nephropathy diagnosis in the follow-up period. Statistically significant (p < 0.05 and highlighted) covariates are listed in Table 4.10 Bivariate Correlations with Follow-up period Nephropathy. The significant positive correlates include age (AGE), base year sum of Rbrvs for co-morbid professional services (CHRBRVS), base year sum of Rbrvs for all professional services (TOTRBRVS), base year flag for any co-morbid disease (CHFLAG), base year flag for any microvascular co-morbid disease (MICFLAG) and base year count of visits for professional services (VISITS).

<table>
<thead>
<tr>
<th>Covariate Variable</th>
<th>Covariate Description</th>
<th>Correlation Coefficient</th>
<th>Significance p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>*MICFLAG</td>
<td>Base Year Flag for Any Microvascular Co-Morbid Disease</td>
<td>+0.137</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>VISITS</td>
<td>Base Year Count of Visits for Professional Services</td>
<td>+0.122</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>TOTRBRVS</td>
<td>Base Year Sum of Rbrvs for All Professional Services</td>
<td>+0.116</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>CHRBRVS</td>
<td>Base Year Sum of Rbrvs for Co-Morbid Professional Services</td>
<td>+0.101</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>CHFLAG</td>
<td>Base Year Flag for Any Co-Morbid Disease</td>
<td>+0.053</td>
<td>0.021</td>
</tr>
<tr>
<td>AGE</td>
<td>Patient Age 7/31/2001</td>
<td>+0.045</td>
<td>0.050</td>
</tr>
<tr>
<td>MACFLAG</td>
<td>Base Year Flag for Any Macrovascular Co-Morbid Disease</td>
<td>+0.031</td>
<td>0.180</td>
</tr>
<tr>
<td>DEPFLAG</td>
<td>Depression Flag (1=Yes, 0=No)</td>
<td>+0.021</td>
<td>0.365</td>
</tr>
<tr>
<td>SEX</td>
<td>Patient Gender (1=Male, 0=Female)</td>
<td>+0.018</td>
<td>0.428</td>
</tr>
</tbody>
</table>

*Table 4.10 Bivariate Correlations with Follow-up Period Nephropathy*

Base year flag for any microvascular disease (MICFLAG) is the significant covariate used to build the baseline logistic regression model as indicated with a single asterisk in Table
4.10 Bivariate Correlations with Follow-up period Nephropathy. This baseline model has an estimated r-squared value between 0.016 and 0.055.

Screening services delivered in the base year of this study are presented independently as additions to this baseline logistic regression model. Table 4.11 Screening Services for Follow-up period Nephropathy documents regression coefficients and significance level for each of these screening services and combinations of screening services entered into the baseline logistic regression model. Statistically significant models are highlighted in gray, representing both overall contributions to model significance and statistically significant regression coefficients of these independent variable additions. A positive regression coefficient is observed for base year screening for albumin with the dependent variable of follow-up period nephropathy.

<table>
<thead>
<tr>
<th>Baseline Regression Model (MICFLAG) + Screening Services</th>
<th>Beta Coefficient (Sig.)</th>
<th>Odds Ratio</th>
<th>Estimated R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Year Eye</td>
<td>- 0.105 (0.676)</td>
<td>0.900</td>
<td>0.016 – 0.056</td>
</tr>
<tr>
<td>Base Year A1C</td>
<td>- 0.176 (0.469)</td>
<td>0.838</td>
<td>0.016 – 0.056</td>
</tr>
<tr>
<td>Base Year Lipids</td>
<td>- 0.349 (0.200)</td>
<td>0.705</td>
<td>0.016 – 0.058</td>
</tr>
<tr>
<td>Base Year Albumin</td>
<td>+ 0.726 (0.009)</td>
<td>2.066</td>
<td>0.019 – 0.066</td>
</tr>
</tbody>
</table>

*Table 4.11 Screening Services for Follow-up period Nephropathy*

The most severe complication for Type 2 diabetics with nephropathy is end stage renal disease (ESRD). In the base year of this study 1.9% of the randomly selected study population has claim evidence of ESRD (36 or 1944 patients). In the follow-up period an additional 58 patients have claim evidence of this co-morbid disease (for a total 94 of 1944 patients by the end of this study). This change in the percentage of the study population with this co-morbid disease is shown graphically in Figure 4.12 Study Population’s Change in ESRD.
Figure 4.12 Study Population’s Change in ESRD

During this study on average three Type 2 diabetic patients per month are first diagnosed with ESRD. The number of patients first diagnosed with ESRD by month is presented in Figure 4.13 Study Population’s First ESRD Diagnosis by Month.

Figure 4.13 Study Population’s First ESRD Diagnosis by Month
Statistical analysis is based on the 1908 patients without claim evidence of end stage renal disease at the end of the base year of this study (36 patients excluded). Several covariate factors are positively correlated with the presence of ESRD in the follow-up period. Statistically significant (p < 0.05 and highlighted) covariates are listed in Table 4.12 Bivariate Correlations with Follow-up period ESRD. The significant positive correlates include age (AGE), base year sum of Rbrvs for co-morbid professional services (CHRBRVS), base year sum of Rbrvs for all professional services (TOTRBRVS), base year flag for any co-morbid disease (CHFLAG), base year flag for any macrovascular co-morbid disease (MACFLAG), base year flag for any microvascular co-morbid disease (MICFLAG) and base year count of visit for professional services (VISITS).

<table>
<thead>
<tr>
<th>Covariate Variable</th>
<th>Covariate Description</th>
<th>Correlation Coefficient</th>
<th>Significance p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>*AGE</td>
<td>Patient Age 7/31/2001</td>
<td>+ 0.114</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>VISITS</td>
<td>Base Year Count of Visits for Professional Services</td>
<td>+ 0.109</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>TOTRBRVS</td>
<td>Base Year Sum of Rbrvs for All Professional Services</td>
<td>+ 0.105</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>MICFLAG</td>
<td>Base Year Flag for Any Microvascular Co-Morbid Disease</td>
<td>+ 0.096</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHRBRVS</td>
<td>Base Year Sum of Rbrvs for Co-Morbid Professional Services</td>
<td>+ 0.090</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>MACFLAG</td>
<td>Base Year Flag for Any Macrovascular Co-Morbid Disease</td>
<td>+ 0.069</td>
<td>0.003</td>
</tr>
<tr>
<td>CHFLAG</td>
<td>Base Year Flag for Any Co-Morbid Disease</td>
<td>+ 0.060</td>
<td>0.008</td>
</tr>
<tr>
<td>SEX</td>
<td>Patient Gender (1=Male, 0=Female)</td>
<td>+ 0.041</td>
<td>0.073</td>
</tr>
<tr>
<td>DEPFLAG</td>
<td>Depression Flag (1=Yes, 0=No)</td>
<td>+ 0.017</td>
<td>0.469</td>
</tr>
</tbody>
</table>

Table 4.12 Bivariate Correlations with Follow-up Period ESRD

Age (AGE) is the significant covariate used to build the baseline logistic regression model. Table 4.12 Bivariate Correlations with Follow-up period ESRD shows AGE as the
covariate selection as indicated with a single asterisk. This baseline model has an estimated r-squared value between 0.014 and 0.060.

Individual screening services delivered in the base year of this study is presented independently as additions to this baseline logistic regression model. Table 4.13 Screening Services for Follow-up period ESRD documents regression coefficients and significance level for each of these screening services and combinations of screening services entered into the baseline logistic regression model. No correlations exist between base year screening services and the presence of end stage renal disease in the follow-up period.

<table>
<thead>
<tr>
<th>Baseline Regression Model (AGE) + Screening Services</th>
<th>Beta Coefficient (Sig.)</th>
<th>Odds Ratio</th>
<th>Estimated R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Year Eye</td>
<td>+ 0.446 (0.101)</td>
<td>1.561</td>
<td>0.016 – 0.066</td>
</tr>
<tr>
<td>Base Year A1C</td>
<td>- 0.554 (0.164)</td>
<td>0.575</td>
<td>0.015 – 0.064</td>
</tr>
<tr>
<td>Base Year Lipids</td>
<td>- 0.754 (0.090)</td>
<td>0.470</td>
<td>0.016 – 0.067</td>
</tr>
<tr>
<td>Base Year Albumin</td>
<td>+ 0.123 (0.806)</td>
<td>1.131</td>
<td>0.014 – 0.060</td>
</tr>
</tbody>
</table>

*Table 4.13 Screening Services for Follow-up Period ESRD*

**Follow-up period Presence of Retinopathy:** Several prominent clusters related to the presence of follow-up period microvascular disease are observed in this study. The findings in this section relate to the microvascular disease of retinopathy.

In the base year of this study 15.1% of the randomly selected study population has claim evidence of retinopathy (294 of 1944 patients). In the follow-up period an additional 251 patients have claim evidence of this co-morbid disease (for a total of 545 of 1944 patients by the end of this study). This change in the percentage of the study population with this co-morbid disease is shown graphically in Figure 4.14 Study Population’s Change in Retinopathy.
Figure 4.14 Study Population’s Change in Retinopathy

During this study on average fifteen Type 2 diabetic patients per month are first diagnosed with retinopathy. The number of patients first diagnosed with retinopathy by month is presented in Figure 4.15 Study Population’s First Retinopathy Diagnosis by Month.

Figure 4.15 Study Population’s First Retinopathy Diagnosis by Month
Statistical analysis is based on the 1650 patients without claim evidence of retinopathy by
the end of the base year of this study (294 patients excluded). Several covariate factors are
positively correlated to the presence of retinopathy diagnosis in the follow-up period.
Statistically significant (p < 0.05 and highlighted) covariates are listed in Table 4.14 Bivariate
Correlations with Follow-up period Retinopathy. The significant positive correlated include age
(AGE), base year sum of Rbrvs for co-morbid professional services (CHRBRVS), base year sum
of Rbrvs for all professional services (TOTRBRVS), base year flag for any microvascular co-
morbid disease, (MICFLAG) and base year count of visits for professional services (VISITS).

<table>
<thead>
<tr>
<th>Covariate Variable</th>
<th>Covariate Description</th>
<th>Correlation Coefficient</th>
<th>Significance p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>*AGE</td>
<td>Patient Age 7/31/2001</td>
<td>+ 0.177</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>VISITS</td>
<td>Base Year Count of Visits for Professional Services</td>
<td>+ 0.086</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHRBRVS</td>
<td>Base Year Sum of Rbrvs for Co-Morbid Professional Services</td>
<td>+ 0.076</td>
<td>0.002</td>
</tr>
<tr>
<td>TOTRBRVS</td>
<td>Base Year Sum of Rbrvs for All Professional Services</td>
<td>+ 0.073</td>
<td>0.003</td>
</tr>
<tr>
<td>CHFLAG</td>
<td>Base Year Flag for Any Co-Morbid Disease</td>
<td>+ 0.066</td>
<td>0.008</td>
</tr>
<tr>
<td>MACFLAG</td>
<td>Base Year Flag for Any Macrovascular Co-Morbid Disease</td>
<td>+ 0.064</td>
<td>0.010</td>
</tr>
<tr>
<td>MICFLAG</td>
<td>Base Year Flag for Any Microvascular Co-Morbid Disease</td>
<td>+ 0.047</td>
<td>0.056</td>
</tr>
<tr>
<td>SEX</td>
<td>Patient Gender</td>
<td>- 0.015</td>
<td>0.549</td>
</tr>
<tr>
<td>DEPFLAG</td>
<td>Depression Flag (1=Yes, 0=No)</td>
<td>- 0.002</td>
<td>0.919</td>
</tr>
</tbody>
</table>

*Table 4.14 Bivariate Correlations with Follow-up Period Retinopathy*

Age (AGE) is the significant covariate used to build the baseline logistics regression
model. Significant variables used to build this baseline logistic regression model are marked with
an asterisk in Table 4.14 Bivariate Correlations with Follow-up period Retinopathy. This
baseline model has an estimated r-squared value between 0.033 and 0.057.
Screening services delivered in the base year of this study are presented independently as additions to this baseline logistics regression model. Table 4.15 Screening Services for Follow-up period Retinopathy documents regression coefficients and significance level for each of these screening services and combinations of screening services entered into the baseline logistic regression model. Statistically significant models are highlighted in gray, representing both overall contributions to model significance and statistically significant regression coefficients of these independent variable additions. A positive regression coefficient is observed for base year screening for albumin with the dependent variable of follow-up period retinopathy.

<table>
<thead>
<tr>
<th>Baseline Regression Model (AGE) + Screening Services</th>
<th>Beta Coefficient (Sig.)</th>
<th>Odds Ratio</th>
<th>Estimated R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Year Eye</td>
<td>+0.155 (0.290)</td>
<td>1.167</td>
<td>0.034 – 0.059</td>
</tr>
<tr>
<td>Base Year A1C</td>
<td>+0.116 (0.518)</td>
<td>1.123</td>
<td>0.033 – 0.058</td>
</tr>
<tr>
<td>Base Year Lipids</td>
<td>+0.120 (0.494)</td>
<td>1.128</td>
<td>0.033 – 0.058</td>
</tr>
<tr>
<td>Base Year Albumin</td>
<td>+0.582 (0.006)</td>
<td>1.789</td>
<td>0.037 – 0.065</td>
</tr>
</tbody>
</table>

*Table 4.15 Screening Services for Follow-up Period Retinopathy*

The most severe complication for Type 2 diabetics with retinopathy is blindness. In the base year of this study two patients have claim evidence of blindness in either or both eyes. The follow-up period of this study has six patients with claim evidence of blindness in either or both eyes. With such a small number of patients suffering from this co-morbid disease of Type 2 diabetes, providing little statistical power, no further analysis is presented.

**Follow-up period Presence of Neuropathy:** Several prominent clusters related to the presence of follow-up period microvascular disease are observed in this study. The findings in this section relate to the microvascular disease of neuropathy.
In the base year of this study 9.3% of the randomly selected study population has claim evidence of neuropathy (181 of 1944 patients). An additional 200 patients have claim evidence of neuropathy during the follow-up period. By the end of the study 19.6% of the randomly selected study population (381 of 1944 patients) has claim evidence of this co-morbid disease. This change in the percentage of the study population with this co-morbid disease is shown graphically in Figure 4.16 Study Population’s Change in Neuropathy.

![Figure 4.16 Study Population’s Change in Neuropathy](image)

During this study on average more than ten Type 2 diabetic patients per month are first diagnosed with neuropathy. The number of patients first diagnosed with neuropathy by month is presented in Figure 4.17 Study Population’s First Neuropathy Diagnosis by Month.
Co-Morbid Disease Neuropathy

Figure 4.17 Study Population’s First Neuropathy Diagnosis by Month

Statistical analysis is based on the 1763 patients without claim evidence of neuropathy by the end of the base year of this study (181 patients excluded). Several covariate factors are positively correlated to the presence of neuropathy diagnosis in the follow-up period. Statistically significant ($p < 0.05$ and highlighted) covariates are listed in Table 4.16 Bivariate Correlations with Follow-up period Neuropathy. The significant positive correlates include age (AGE), gender (SEX), base year sum of Rbrvs for co-morbid professional services (CHRBRVS), base year sum of Rbrvs for all professional services (TOTRBRVS), base year flag for any co-morbid disease (CHFLAG), base year flag for any macrovascular co-morbid disease (MACFLAG), base year flag for any microvascular co-morbid disease (MICFLAG), and base year count of visits for professional services (VISITS).
<table>
<thead>
<tr>
<th>Covariate Variable</th>
<th>Covariate Description</th>
<th>Correlation Coefficient</th>
<th>Significance p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>*VISITS</td>
<td>Base Year Count of Visits for Professional Services</td>
<td>+ 0.191</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>TOTRBRVS</td>
<td>Base Year Sum of Rbrvs for All Professional Services</td>
<td>+ 0.181</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>AGE</td>
<td>Patient Age 7/31/2001</td>
<td>+ 0.148</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHRBRVS</td>
<td>Base Year Sum of Rbrvs for Co-Morbid Professional Services</td>
<td>+ 0.110</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>MACFLAG</td>
<td>Base Year Flag for Any Macrovascular Co-Morbid Disease</td>
<td>+ 0.109</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHFLAG</td>
<td>Base Year Flag for Any Co-Morbid Disease</td>
<td>+ 0.102</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>MICFLAG</td>
<td>Base Year Flag for Any Microvascular Co-Morbid Disease</td>
<td>+ 0.069</td>
<td>0.004</td>
</tr>
<tr>
<td>SEX</td>
<td>Patient Gender (1=Male, 0=Female)</td>
<td>- 0.066</td>
<td>0.006</td>
</tr>
<tr>
<td>DEPFLAG</td>
<td>Depression Flag (1=Yes, 0=No)</td>
<td>+ 0.008</td>
<td>0.730</td>
</tr>
</tbody>
</table>

*Table 4.16 Bivariate Correlations with Follow-up period Neuropathy*

Base year count of visits for professional services (VISITS) is the significant covariate used to build the baseline logistic regression model as indicated by the asterisk in Table 4.16 Bivariate Correlations with Follow-up period Neuropathy. This baseline model has an estimated r-squared value between 0.027 and 0.054.

Each combination of screening services delivered in the base year of this study is presented independently as additions to this baseline logistic regression model. Table 4.17 Combinations of Screening Services for Follow-up period Neuropathy documents regression coefficients and significance level for each of these screening services and combinations of screening services entered into this baseline logistic regression model. Statistically significant models are highlighted in gray, representing both overall contributions to model significance and statistically significant regression coefficients of these independent variable additions. Significant negative regression coefficients are observed for both base year screening services for A1C testing and lipids testing with the dependent variable follow-up period neuropathy.
<table>
<thead>
<tr>
<th>Baseline Regression Model (VISITS) + Screening Services</th>
<th>Beta Coefficient (Sig.)</th>
<th>Odds Ratio</th>
<th>Estimated R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Year Eye</td>
<td>+ 0.15 (0.926)</td>
<td>1.015</td>
<td>0.027 – 0.054</td>
</tr>
<tr>
<td>Base Year A1C</td>
<td>- 0.561 (0.001)</td>
<td>0.571</td>
<td>0.034 – 0.066</td>
</tr>
<tr>
<td>Base Year Lipids</td>
<td>- 0.488 (0.007)</td>
<td>0.614</td>
<td>0.031 – 0.062</td>
</tr>
<tr>
<td>Base Year Albumin</td>
<td>- 0.140 (0.554)</td>
<td>0.870</td>
<td>0.027 – 0.054</td>
</tr>
<tr>
<td>Base Year Eye + A1C</td>
<td>- 0.020 (0.901)</td>
<td>0.981</td>
<td>0.034 – 0.066</td>
</tr>
<tr>
<td>Base Year Eye + Lipids</td>
<td>- 0.004 (0.979)</td>
<td>0.996</td>
<td>0.031 – 0.062</td>
</tr>
<tr>
<td>Base Year Eye + Albumin</td>
<td>+ 0.015 (0.925)</td>
<td>1.015</td>
<td>0.027 – 0.054</td>
</tr>
<tr>
<td>Base Year A1C + Lipids</td>
<td>- 0.451 (0.030)</td>
<td>0.637</td>
<td>0.034 – 0.067</td>
</tr>
<tr>
<td>Base Year A1C + Albumin</td>
<td>- 0.618 (0.001)</td>
<td>0.539</td>
<td>0.034 – 0.067</td>
</tr>
<tr>
<td>Base Year Lipids + Albumin</td>
<td>- 0.520 (0.008)</td>
<td>0.594</td>
<td>0.032 – 0.062</td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids</td>
<td>- 0.021 (0.894)</td>
<td>0.979</td>
<td>0.034 – 0.067</td>
</tr>
<tr>
<td>Base Year A1C + Lipids + Albumin</td>
<td>- 0.452 (0.030)</td>
<td>0.636</td>
<td>0.034 – 0.067</td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids + Albumin</td>
<td>- 0.619 (0.001)</td>
<td>0.538</td>
<td>0.034 – 0.067</td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids + Albumin</td>
<td>+ 0.207 (0.425)</td>
<td>1.230</td>
<td></td>
</tr>
<tr>
<td>Base Year Eye + Lipids + Albumin</td>
<td>- 0.005 (0.975)</td>
<td>0.995</td>
<td>0.032 – 0.062</td>
</tr>
<tr>
<td>Base Year A1C + Lipids + Albumin</td>
<td>- 0.498 (0.020)</td>
<td>0.608</td>
<td>0.035 – 0.068</td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids + Albumin</td>
<td>- 0.238 (0.307)</td>
<td>0.788</td>
<td></td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids + Albumin</td>
<td>+ 0.260 (0.326)</td>
<td>1.297</td>
<td></td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids + Albumin</td>
<td>- 0.024 (0.877)</td>
<td>0.976</td>
<td>0.035 – 0.068</td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids + Albumin</td>
<td>- 0.499 (0.020)</td>
<td>0.607</td>
<td></td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids + Albumin</td>
<td>- 0.239 (0.306)</td>
<td>0.787</td>
<td></td>
</tr>
<tr>
<td>Base Year Eye + A1C + Lipids + Albumin</td>
<td>+ 0.261 (0.324)</td>
<td>1.298</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.17 Combinations of Screening Services for Follow-up Period Neuropathy

Two valid statistical models are derived from this analysis. Follow-up period neuropathy is modeled by $Y_5 = -2.280 + (0.049 \times VISITS) - (0.561 \times A1C)$. Another model can be used for follow period neuropathy as demonstrated by $Y_6 = -2.393 + (0.052 \times VISITS) - (0.488 \times LIPID)$.

The most severe complication for Type 2 diabetics with the co-morbid disease neuropathy is lower extremity amputation (LEA). In the base year of this study one patient has claim evidence of LEA. The follow-up period of this study has six patients with claim evidence
of LEA. With such a small number of patients suffering from this co-morbid disease of Type 2 diabetes, providing little statistical power, no further analysis is presented.

**Follow-up period Presence of Hypertension:** In the base year of this study one-third of the randomly selected study population has claim evidence of hypertension (649 of 1944 patients). In the follow-up period an additional 647 patients have claim evidence of hypertension (for a total of 1296 of 1944 patients by the end of this study). This change in the percentage of the study population with this co-morbid disease is shown graphically in Figure 4.18, Study Population’s Change in Hypertension.

![Co-Morbid Disease Hypertension](image)

*Figure 4.18 Study Population’s Change in Hypertension*

An average of thirty-six patients per month has first claim evidence of hypertension throughout this study. Based on claims data from this study, the number of patients first
diagnosed with hypertension is presented in Figure 4.19 Study Population’s First Hypertension Diagnosis by Month.

![Figure 4.19 Study Population’s First Hypertension Diagnosis by Month](image)

Statistical analysis is based on the 1295 patients without hypertension at the end of the base year (649 patients excluded). Several covariate factors are positively correlated to the presence of hypertension diagnosis in the follow-up period. Statistically significant (p < 0.05 and highlighted) covariates are listed in Table 4.18 Bivariate Correlations with Follow-up period Hypertension. The significant positive correlates include age (AGE), base year sum of Rbrvs for co-morbid professional services (CHRBRVS), base year sum of all professional services (TOTRBRVS), base year flag for any co-morbid disease (CHFLAG), base year flag for any macrovascular co-morbid disease (MACFLAG), base year flag for any microvascular co-morbid disease (MICFLAG) and base year count of visits for professional services (VISITS).
<table>
<thead>
<tr>
<th>Covariate Variable</th>
<th>Covariate Description</th>
<th>Correlation Coefficient</th>
<th>Significance p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>*AGE</td>
<td>Patient Age 7/31/2001</td>
<td>+ 0.209</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>VISITS</td>
<td>Base Year Count of Visits for Professional Services</td>
<td>+ 0.166</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>TOTRBRVS</td>
<td>Base Year Sum of Rbrvs for All Professional Services</td>
<td>+ 0.140</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHRBRVS</td>
<td>Base Year Sum of Rbrvs for Co-Morbid Professional Services</td>
<td>+ 0.125</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>MACFLAG</td>
<td>Base Year Flag for Any Macrovascular Co-Morbid Disease</td>
<td>+ 0.112</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHFLAG</td>
<td>Base Year Flag for Any Co-Morbid Disease</td>
<td>+ 0.109</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>MICFLAG</td>
<td>Base Year Flag for Any Microvascular Co-Morbid Disease</td>
<td>+ 0.070</td>
<td>0.012</td>
</tr>
<tr>
<td>SEX</td>
<td>Patient Gender</td>
<td>- 0.046</td>
<td>0.101</td>
</tr>
<tr>
<td>DEPFLAG</td>
<td>Depression Flag (1=Yes, 0=No)</td>
<td>- 0.022</td>
<td>0.431</td>
</tr>
</tbody>
</table>

Table 4.18 Bivariate Correlations with Follow-up period Hypertension

Age (AGE) is the significant covariate used to build the baseline logistic regression model. This baseline model has an estimated $r$-squared value between 0.044 and 0.058.

Screening services delivered in the base year of this study are presented independently as additions to this baseline logistic regression model. Table 4.19 Screening Services for Follow-up period Hypertension documents regression coefficients and significance level for each of these screening services and combinations of screening services entered into the baseline logistic regression model. Statistically significant models are highlighted in gray, representing both overall contributions to model significance and statistically significant regression coefficients of these independent variable additions. Significant positive regression coefficients are observed for both base year screening services for eye exams and lipids testing with the dependent variable of follow-up period hypertension.
<table>
<thead>
<tr>
<th>Baseline Regression Model (AGE) + Screening Services</th>
<th>Beta Coefficient (Sig.)</th>
<th>Odds Ratio</th>
<th>Estimated R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Year Eye</td>
<td>+ 0.239 (0.044)</td>
<td>1.270</td>
<td>0.047 – 0.062</td>
</tr>
<tr>
<td>Base Year A1C</td>
<td>+ 0.102 (0.447)</td>
<td>1.107</td>
<td>0.044 – 0.059</td>
</tr>
<tr>
<td>Base Year Lipids</td>
<td>+ 0.288 (0.024)</td>
<td>1.334</td>
<td>0.047 – 0.063</td>
</tr>
<tr>
<td>Base Year Albumin</td>
<td>+ 0.265 (0.112)</td>
<td>1.303</td>
<td>0.046 – 0.061</td>
</tr>
</tbody>
</table>

Table 4.19 Screening Services for Follow-up period Hypertension

**Follow-up period Presence of Dyslipidemia:** In the base year of this study just over 13% of the study population had claim evidence of dyslipidemia (262 of 1944 patients). In the follow-up period an additional 605 patients have claim evidence of dyslipidemia (for a total of 867 of 1944 patients by the end of this study). This change in the percentage of the study population with this co-morbid disease is shown graphically in Figure 4.20 Study Population’s Change in Dyslipidemia.

**Co-Morbid Disease Dyslipidemia**

![Figure 4.20 Study Population’s Change in Dyslipidemia](image)
On average twenty-four patients each month are first diagnosed with this co-morbid disease. The number of patients first diagnosed with dyslipidemia by month is presented in Figure 4.21 Study Population’s First Dyslipidemia Diagnosis by Month.

![Figure 4.21 Study Population’s First Dyslipidemia Diagnosis by Month](image)

Statistical analysis is based on the 1682 patients without dyslipidemia at the end of the base year of this study. Several covariate factors are positively correlated to the presence of dyslipidemia in the follow-up period. Statistically significant (p < 0.05 and highlighted) covariates are listed in Table 4.20 Bivariate Correlations with Follow-up period Dyslipidemia. The significant positive correlates include age (AGE), base year sum of Rbrvs for co-morbid professional services (CHRBRVS), base year flag for any co-morbid disease (CHFLAG) and base year flag for any macrovascular co-morbid disease (MACFLAG).
<table>
<thead>
<tr>
<th>Covariate Variable</th>
<th>Covariate Description</th>
<th>Correlation Coefficient</th>
<th>Significance p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>*MACFLAG</td>
<td>Base Year Flag for Any Macrovascular Co-Morbid Disease</td>
<td>+ 0.132</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHFLAG</td>
<td>Base Year Flag for Any Co-Morbid Disease</td>
<td>+ 0.106</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHRBRVS</td>
<td>Base Year Sum of Rbrvs for Co-Morbid Professional Services</td>
<td>+ 0.078</td>
<td>0.001</td>
</tr>
<tr>
<td>AGE</td>
<td>Patient Age 7/31/2001</td>
<td>+ 0.075</td>
<td>0.002</td>
</tr>
<tr>
<td>SEX</td>
<td>Patient Gender (1=Male, 0=Female)</td>
<td>+ 0.045</td>
<td>0.064</td>
</tr>
<tr>
<td>DEPFLAG</td>
<td>Depression Flag (1=Yes, 0=No)</td>
<td>- 0.040</td>
<td>0.103</td>
</tr>
<tr>
<td>VISITS</td>
<td>Base Year Count of Visits for Professional Services</td>
<td>+ 0.038</td>
<td>0.117</td>
</tr>
<tr>
<td>TOTRBRVS</td>
<td>Base Year Sum of Rbrvs for All Professional Services</td>
<td>+ 0.026</td>
<td>0.294</td>
</tr>
<tr>
<td>MICFLAG</td>
<td>Base Year Flag for Any Microvascular Co-Morbid Disease</td>
<td>+ 0.008</td>
<td>0.742</td>
</tr>
</tbody>
</table>

*Table 4.20 Bivariate Correlations with Follow-up period Dyslipidemia*

Base year flag for any macrovascular co-morbid disease (MACFLAG) is the significant covariate used to build this baseline logistic regression model. Significant variables used to build this baseline logistic regression model are marked with an asterisk in Table 4.20 Bivariate Correlations with Follow-up period Dyslipidemia. This baseline model has an estimated r-squared value between 0.017 and 0.024.

Screening services delivered in the base year of this study are presented independently as additions to this baseline logistic regression model. Table 4.21 Screening Services for Follow-up period Dyslipidemia documents regression coefficients and significance level for each of these screening services and combinations of screening services entered into the baseline logistic regression model. Statistically significant models are highlighted in gray, representing both overall contributions to model significance and statistically significant regression coefficients of these independent variable additions. Significant positive regression coefficients are observed for base year screening services for lipids testing.
Baseline Regression Model (MACFLAG) + Screening Services

<table>
<thead>
<tr>
<th></th>
<th>Beta Coefficient (Sig.)</th>
<th>Odds Ratio</th>
<th>Estimated R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Year Eye</td>
<td>+ 0.096 (0.363)</td>
<td>1.101</td>
<td>0.018 – 0.024</td>
</tr>
<tr>
<td>Base Year A1C</td>
<td>+ 0.031 (0.764)</td>
<td>1.032</td>
<td>0.017 – 0.024</td>
</tr>
<tr>
<td>Base Year Lipids</td>
<td>+ 0.408 (&lt; 0.0005)</td>
<td>1.504</td>
<td>0.025 – 0.035</td>
</tr>
<tr>
<td>Base Year Albumin</td>
<td>+ 0.248 (0.090)</td>
<td>1.282</td>
<td>0.019 – 0.026</td>
</tr>
</tbody>
</table>

*Table 4.21 Screening Services for Follow-up period Dyslipidemia*

**Follow-up period Presence of Cardiovascular Disease:** In the base year of this study 17.8% of the randomly selected study population has claim evidence of cardiovascular disease (347 of 1944 patients). In the follow-up period an additional 265 patients have claim evidence of cardiovascular disease (for a total of 612 of 1944 patients by the end of this study). This change in the percentage of the study population with this co-morbid disease is shown graphically in Figure 4.22 Study Population’s Change in Cardiovascular Disease.

**Co-Morbid Disease Cardiovascular**

*Figure 4.22 Study Population’s Change in Cardiovascular Disease*
After the first six months of this study thirteen patients each month on average are first diagnosed with cardiovascular disease. The number of patients first diagnosed with cardiovascular disease by month is presented in Figure 4.23 Study Population’s First Cardiovascular Disease Diagnosis by Month.

![Figure 4.23 Study Population’s First Cardiovascular Disease Diagnosis by Month](image)

Statistical analysis is based on the 1597 patients without evidence of cardiovascular disease at the end of the base year of this study (347 patients excluded). Several covariate factors are positively correlated to the presence of cardiovascular disease diagnosis in the follow-up period. Statistically significant (p < 0.05 and highlighted) covariates are listed in Table 4.22 Bivariate Correlations with Follow-up period Cardiovascular Disease. The significant positive correlates include age (AGE), base year sum of Rbrvs for co-morbid professional services (CHRBRVS), base year sum of Rbrvs for all professional services (TOTRBRVS), base year flag for any co-morbid disease (CHFLAG), base year flag for any macrovascular co-morbid disease
(MACFLAG), base year flag for any microvascular co-morbid disease (MICFLAG) and base year count of visits for professional services (VISITS).

<table>
<thead>
<tr>
<th>Covariate Variable</th>
<th>Covariate Description</th>
<th>Correlation Coefficient</th>
<th>Significance p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>*AGE</td>
<td>Patient Age 7/31/2001</td>
<td>+ 0.279</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>VISITS</td>
<td>Base Year Count of Visits for Professional Services</td>
<td>+ 0.201</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>TOTRBRVS</td>
<td>Base Year Sum of Rbrvs for All Professional Services</td>
<td>+ 0.171</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHRBRVS</td>
<td>Base Year Sum of Rbrvs for Co-Morbid Professional Services</td>
<td>+ 0.122</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHFLAG</td>
<td>Base Year Flag for Any Co-Morbid Disease</td>
<td>+ 0.084</td>
<td>0.001</td>
</tr>
<tr>
<td>MICFLAG</td>
<td>Base Year Flag for Any Microvascular Co-Morbid Disease</td>
<td>+ 0.077</td>
<td>0.002</td>
</tr>
<tr>
<td>MACFLAG</td>
<td>Base Year Flag for Any Macrovascular Co-Morbid Disease</td>
<td>+ 0.075</td>
<td>0.003</td>
</tr>
<tr>
<td>DEPFLAG</td>
<td>Depression Flag (1=Yes, 0=No)</td>
<td>- 0.021</td>
<td>0.402</td>
</tr>
<tr>
<td>SEX</td>
<td>Patient Gender (1=Male, 0=Female)</td>
<td>- 0.003</td>
<td>0.918</td>
</tr>
</tbody>
</table>

*Table 4.22 Bivariate Correlations with Follow-up Period Cardiovascular Disease*

Age (AGE) is the significant covariate used to build the baseline logistic regression model. Significant variables used to build this baseline logistic regression model are marked with a single asterisk in Table 4.22 Bivariate Correlations with Follow-up period Cardiovascular Disease. This baseline model has an estimated r-squared value between 0.083 and 0.139.

Screening services delivered in the base year of this study are presented independently as additions to this baseline logistic regression model. Table 4.23 Combinations of Screening Services for Follow-up period Cardiovascular Disease documents regression coefficients and significance level for each of these screening services and combinations of screening services entered into the baseline logistic regression model. Statistically significant models are highlighted in gray, representing both overall contributions to model significance and statistically significant regression coefficients of these independent variable additions. No significant
regression coefficients are observed for base year screening services and follow-up period cardiovascular disease.

<table>
<thead>
<tr>
<th>Baseline Regression Model (AGE) + Screening Services</th>
<th>Beta Coefficient (Sig.)</th>
<th>Odds Ratio</th>
<th>Estimated R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Year Eye</td>
<td>- 0.121 (0.408)</td>
<td>0.886</td>
<td>0.083 – 0.140</td>
</tr>
<tr>
<td>Base Year A1C</td>
<td>- 0.110 (0.551)</td>
<td>0.896</td>
<td>0.083 – 0.140</td>
</tr>
<tr>
<td>Base Year Lipids</td>
<td>+ 0.102 (0.575)</td>
<td>1.107</td>
<td>0.083 – 0.140</td>
</tr>
<tr>
<td>Base Year Albumin</td>
<td>+ 0.101 (0.662)</td>
<td>1.107</td>
<td>0.083 – 0.140</td>
</tr>
</tbody>
</table>

Table 4.23 Screening Services for Follow-up Period Cardiovascular Disease

**Follow-up period Presence of Stroke:** In the base year of this study sixty-eight (3.5%) patients have claim evidence of stroke. In the follow-up period an additional 125 patients have claim evidence of stroke (for a total of 193 of 1944 patients by the end of this study). This change in the percentage of the study population with this co-morbid disease is shown graphically in Figure 4.24 Study Population’s Change in Stroke.

![Co-Morbid Disease Stroke](image)

*Figure 4.24 Study Population’s Change in Stroke*
More than five Type 2 diabetic patients are first diagnosed with this co-morbid disease each month. The number of patients first diagnosed with this disease by month is presented in Figure 4.25 Study Population’s First Stroke Diagnosis by Month.

![Co-Morbid Disease Stroke](image)

**Figure 4.25 Study Population’s First Stroke Diagnosis by Month**

Statistical analysis is based on the 1876 patients without evidence of stroke in the base year of this study (68 patients excluded). Several covariate factors are positively correlated to the presence of stroke diagnosis in the follow-up period. Statistically significant (p < 0.05 and highlighted) covariates are listed in Table 4.24 Bivariate Correlations with Follow-up period Stroke. The significant positive correlates include age (AGE), base year sum of Rbrvs for co-morbid professional services (CHRBRVS), base year sum of Rbrvs for all professional services (TOTRBRVS), base year flag for any co-morbid disease (CHFLAG), base year flag for any macrovascular co-morbid disease (MACFLAG), base year flag for any microvascular co-morbid disease (MICFLAG), and base year count of visits for professional services (VISITS).
<table>
<thead>
<tr>
<th>Covariate Variable</th>
<th>Covariate Description</th>
<th>Correlation Coefficient</th>
<th>Significance p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>*AGE</td>
<td>Patient Age 7/31/2001</td>
<td>+ 0.195</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>CHRBRVS</td>
<td>Base Year Sum of Rbrvs for Co-Morbid Professional Services</td>
<td>+ 0.137</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>VISITS</td>
<td>Base Year Count of Visits for Professional Services</td>
<td>+ 0.123</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>TOTRBRVS</td>
<td>Base Year Sum of Rbrvs for All Professional Services</td>
<td>+ 0.119</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td>MACFLAG</td>
<td>Base Year Flag for Any Macrovascular Co-Morbid Disease</td>
<td>+ 0.068</td>
<td>0.003</td>
</tr>
<tr>
<td>CHFLAG</td>
<td>Base Year Flag for Any Co-Morbid Disease</td>
<td>+ 0.066</td>
<td>0.004</td>
</tr>
<tr>
<td>MICFLAG</td>
<td>Base Year Flag for Any Microvascular Co-Morbid Disease</td>
<td>+ 0.058</td>
<td>0.012</td>
</tr>
<tr>
<td>SEX</td>
<td>Patient Gender (1=Male, 0=Female)</td>
<td>+ 0.034</td>
<td>0.140</td>
</tr>
<tr>
<td>DEPFLAG</td>
<td>Depression Flag (1=Yes, 0=No)</td>
<td>+ 0.020</td>
<td>0.398</td>
</tr>
</tbody>
</table>

*Table 4.24 Bivariate Correlations with Follow-up period Stroke*

Age (AGE) is the significant covariate used to build the baseline logistic regression model. Significant variables used to build this baseline logistic regression model are marked with a single asterisk in Table 4.24 Bivariate Correlations with Follow-up period Stroke. This baseline model has an estimated r-squared value between 0.042 and 0.109.

Screening services delivered in the base year of this study are presented independently as additions to this baseline logistic regression model. Table 4.25 Screening Services for Follow-up Period Stroke documents regression coefficients and significance level for each of these screening services and combinations of screening services entered into the baseline logistic regression model. No screening services are found to have significant associations with the dependent variable, follow-up period stroke diagnosis.
### Table 4.25 Screening Services for Follow-up period Stroke

<table>
<thead>
<tr>
<th>Baseline Regression Model (AGE) + Screening Services</th>
<th>Beta Coefficient (Sig.)</th>
<th>Odds Ratio</th>
<th>Estimated R-Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Year Eye</td>
<td>+ 0.132 (0.491)</td>
<td>1.141</td>
<td>0.042 – 0.109</td>
</tr>
<tr>
<td>Base Year A1C</td>
<td>+ 0.081 (0.762)</td>
<td>1.085</td>
<td>0.042 – 0.109</td>
</tr>
<tr>
<td>Base Year Lipids</td>
<td>+ 0.071 (0.802)</td>
<td>1.073</td>
<td>0.042 – 0.109</td>
</tr>
<tr>
<td>Base Year Albumin</td>
<td>- 0.325 (0.432)</td>
<td>0.723</td>
<td>0.042 – 0.110</td>
</tr>
</tbody>
</table>

**Table 4.26 Summary of Significant Cost Findings**

Costs: Table 4.26 Summary of significant costs findings reveals significant positive associations between health-screening services and follow-up period costs. Base year eye exams are associated with an average $1754 in higher follow-up period costs. Base year A1C testing is associated with an average $4255 in higher follow-up period costs. Base year lipid testing is associated with an average $3752 in higher follow-up period costs. And, albumin testing in the base year of this study is associated with average $5063 in higher follow-up period costs. Further, base year albumin testing is associated with an increased risk (24.1%) of higher follow-up period costs compared to base year costs.

<table>
<thead>
<tr>
<th>Outcome Variable</th>
<th>Screening Service</th>
<th>Regression Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>Eye Exam</td>
<td>+ 1753.93</td>
</tr>
<tr>
<td></td>
<td>A1C Testing</td>
<td>+ 4255.36</td>
</tr>
<tr>
<td></td>
<td>Lipids Testing</td>
<td>+ 3752.33</td>
</tr>
<tr>
<td></td>
<td>Albumin Testing</td>
<td>+ 5063.29</td>
</tr>
<tr>
<td>Costs Change</td>
<td>Albumin Testing</td>
<td>+1.241</td>
</tr>
</tbody>
</table>

**Statistical Analysis Summary**

Table 4.26 Summary of Significant Cost Findings
Utilization: Table 4.27 Summary of significant utilization findings reveals a negative association between health-screening services and follow-up period acute care services. Base year lipid testing is associated with lower emergency department utilization by a rate of one hundred eighty-eight visits per thousand patients in one year. Base year A1C testing is associated with lower acute inpatient admissions by a rate of two hundred thirty-six admissions per thousand patients in one year. Base year lipid testing is associated with lower acute inpatient admissions by a rate of two hundred twenty-three admissions per thousand patients in one year. Base year albumin testing is associated with lower acute inpatient admissions by a rate of one hundred sixty-nine admissions per thousand patients in one year.

<table>
<thead>
<tr>
<th>Utilization</th>
<th>Screening Service</th>
<th>Regression Coefficient</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Department Visits</td>
<td>Lipids Testing</td>
<td>-0.188</td>
<td>0.013</td>
</tr>
<tr>
<td>Acute Inpatient Admission</td>
<td>A1C Testing</td>
<td>-0.236</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td></td>
<td>Lipids Testing</td>
<td>-0.223</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td></td>
<td>Albumin Testing</td>
<td>-0.169</td>
<td>0.008</td>
</tr>
</tbody>
</table>

Table 4.27 Summary of Significant Utilization Findings

Health Outcomes: Table 4.28 Summary of significant health outcome findings reveals several significant associations between health-screening services and the onset of microvascular and macrovascular diseases for Type 2 diabetic patients.

This study indicates albumin testing is associated with higher rates for the onset of nephrology and retinopathy in the follow-up period. An odds ratio of 2.066 exists between base year albumin testing and follow-up period onset of nephrology. An odds ratio of 1.789 is observed between base year albumin testing and follow-up period onset of retinopathy.
<table>
<thead>
<tr>
<th>Health Outcomes</th>
<th>Screening Service</th>
<th>Odds Ratio</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follow-Up Period Nephropathy</td>
<td>Albumin Testing</td>
<td>2.066</td>
<td>0.009</td>
</tr>
<tr>
<td>Follow-Up Period Retinopathy</td>
<td>Albumin Testing</td>
<td>1.789</td>
<td>0.006</td>
</tr>
<tr>
<td>Follow-Up Period Neuropathy</td>
<td>A1C Testing Lipids Testing</td>
<td>0.571 0.614</td>
<td>0.001 0.007</td>
</tr>
<tr>
<td>Follow-Up Period Hypertension</td>
<td>Eye Exam Lipids Testing</td>
<td>1.270 1.334</td>
<td>0.044 0.024</td>
</tr>
<tr>
<td>Follow-Up Period Dyslipidemia</td>
<td>Lipids Testing</td>
<td>1.504</td>
<td>&lt; 0.0005</td>
</tr>
</tbody>
</table>

*Table 4.28 Summary of Significant Health Outcome Findings*

Odds ratios less than one is observed for both A1C and lipid testing and onset of follow-up period neuropathy. A1C testing in the base year is associated with 43% lower incidence of follow-up period neuropathy. Lipid testing in the base year is association with 39% lower incidence of follow-up period neuropathy.

An odds ratio greater than one is observed for the macrovascular disease of hypertension and both eye exams and lipids testing. Base year eye exams are associated with a 27.0% increased likelihood of follow-up period hypertension. Base year lipids testing is associated with a 33.4% increased likelihood of follow-up period hypertension.

An odds ratio greater than one is also observed for macrovascular disease of dyslipidemia and base year lipids testing. Lipids testing in the base year of this study are associated with a 50.4% increase in follow-up period dyslipidemia.
SUMMARY OF CHAPTER FINDINGS

The central hypothesis of this study is preventive screening services improve outcomes for patients with Type 2 diabetes. This study includes three sub hypotheses to this central hypothesis:

\[ H_1: \text{Health-screening services in the base year are associated with lower follow-up period costs for patients with Type 2 diabetes.} \]

While exploratory analysis reveals clusters of low costs patients in the follow-up period, these clusters are not associated with base year health-screening services beyond A1C testing. Statistical analysis of the entire study population reveals the following associations between health-screening services and follow-up period costs (holding all other research variables constant):

- Base year eye exams are associated with an increase in follow-up period costs of $1754.
- Base year A1C testing is associated with an increase in follow-up period costs of $4255.
- Base year lipids testing is associated with an increase in follow-up period costs of $3752.
- Base year albumin testing is associated with an increase in follow-up period costs of $5063.
- Base year Albumin testing is associated with a 24.1% greater chance of follow-up period annual costs increases above base year costs.

The empirical evidence of this study does not support this hypothesis that health-screening services in the base year are associated with lower follow-up period costs for patients with Type 2 diabetes.
**H3: Health-screening services in the base year are associated with lower follow-up period inpatient utilization for patients with Type 2 diabetes.**

While exploratory analysis reveals clusters of low utilizing patients of acute care services (ED and inpatient admissions) in the follow-up period, these clusters are not associated with base year health-screening services beyond A1C and lipids testing. Statistical analysis of the entire study population reveals the following associations between health-screening services and follow-up period utilization of acute care services (holding all other research variables constant):

- Base year lipid testing is associated with lower emergency department utilization of 188 visits/1000 patients per year.
- Base year A1C testing is associated with lower acute inpatient utilization of 236 admissions/1000 patients per year.
- Base year lipid testing is associated with lower acute inpatient utilization of 223 admissions/1000 patients per year.
- Base year albumin testing is associated with lower acute inpatient utilization of 169 admissions/1000 patients per year.

The empirical evidence of this study does support this hypothesis that health-screening services in the base year are associated with lower follow-up period utilization of acute care services for patients with Type 2 diabetes.

**H3: Health-screening services in the base year improve health outcomes by delaying the onset of co-morbid disease for patients with Type 2 diabetes.**

Exploratory analysis of microvascular disease reveals clusters of both younger Type 2 diabetic patients without co-morbid disease and older Type 2 diabetic patients with co-morbid disease. These clusters are associated with health-screening services of both A1C testing and lipids testing. These prominent clusters are also associated with lack of evidence of microvascular disease in the follow-up period. Statistical analysis of the components of microvascular disease
confirms these exploratory findings. The following associations are observed between health-screening services and follow-up period presence of microvascular disease (holding all other research variables constant):

- Base year A1C testing is associated with a 42.9% lower rate of the onset of neuropathy in the twenty-four months of the follow-up period.
- Base year lipid testing is associated with a 38.6% lower rate of the onset of neuropathy in the twenty-four months of the follow-up period.

The empirical evidence of this study does support this hypothesis that health-screening services in the base year are associated with delay in the onset of microvascular disease (neuropathy) for patients with Type 2 diabetes.
VALIDATION

It is important to validate findings from regression models by using data sets different from the data set used to build such models (Bowerman, 2001). Comparable datasets should be used in completing validation of study findings. Table 4.29 - Comparison of Base Study and Validation Study Groups confirm similarities in characteristics of two cohorts of patients; those included in the base study (n=1944) and those included in the validation study group (n=1953).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Base Study (1944 Records)</th>
<th>Validation Study (1953 Records)</th>
<th>Significance Difference p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td>61.94</td>
<td>62.04</td>
<td>0.832</td>
</tr>
<tr>
<td>SEX</td>
<td>49.3% Female</td>
<td>49.5% Female</td>
<td>0.935</td>
</tr>
<tr>
<td>DEPFLAG</td>
<td>3.4%</td>
<td>3.1%</td>
<td>0.569</td>
</tr>
<tr>
<td>CHRBRV5</td>
<td>4.33 Units</td>
<td>4.12 Units</td>
<td>0.360</td>
</tr>
<tr>
<td>TOTRBRV5</td>
<td>15.57 Units</td>
<td>15.29 Units</td>
<td>0.604</td>
</tr>
<tr>
<td>CHFLAG</td>
<td>60.9% Co-Morbid Disease</td>
<td>61.3% Co-Morbid Disease</td>
<td>0.780</td>
</tr>
<tr>
<td>MACFLAG</td>
<td>51.4%</td>
<td>50.1%</td>
<td>0.413</td>
</tr>
<tr>
<td>MICFLAG</td>
<td>23.8%</td>
<td>24.7%</td>
<td>0.482</td>
</tr>
<tr>
<td>VISITS</td>
<td>8.55 Visits</td>
<td>8.36 Visits</td>
<td>0.455</td>
</tr>
<tr>
<td>BASE_ER</td>
<td>17.5/1000 Patients</td>
<td>24.6/1000 Patients</td>
<td>0.572</td>
</tr>
<tr>
<td>BASE_IP</td>
<td>11.3/1000 Patients</td>
<td>6.1/1000 Patients</td>
<td>0.259</td>
</tr>
<tr>
<td>EYE</td>
<td>38.9%</td>
<td>40.1%</td>
<td>0.442</td>
</tr>
<tr>
<td>A1C</td>
<td>46.6%</td>
<td>45.1%</td>
<td>0.333</td>
</tr>
<tr>
<td>LIPID</td>
<td>33.5%</td>
<td>34.0%</td>
<td>0.787</td>
</tr>
<tr>
<td>ALBUMIN</td>
<td>14.3%</td>
<td>13.5%</td>
<td>0.480</td>
</tr>
</tbody>
</table>

Table 4.29 Comparison of Base Study and Validation Study Groups
This analysis has identified 6 statistically significant findings that support study hypotheses. Each of these findings is validated by using a cross-validation technique. This process compares predicted outcome values with observed values in the validation dataset through applying predictive models from this study to data in the validation cohort of patients. Study findings, base study group and validation group statistics and the correlation between expected and observed values for this validation process are presented in Table 4.30 - Validation of Study Findings.

<table>
<thead>
<tr>
<th>Significant Finding</th>
<th>Statistic</th>
<th>Base/Validation Statistic (Significance)</th>
<th>Validation Correlation (Significance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1: Base Lipid Testing Association Follow-Up ED Utilization</td>
<td>Regression Coefficient</td>
<td>-0.188 (0.013) -0.226 (&lt; 0.0005)</td>
<td>0.356 (&lt; 0.0005)</td>
</tr>
<tr>
<td>#2 Base A1C Testing Association Follow-Up Inpatient Admissions</td>
<td>Regression Coefficient</td>
<td>-0.236 (&lt; 0.0005) -0.246 (&lt; 0.0005)</td>
<td>0.348 (&lt; 0.0005)</td>
</tr>
<tr>
<td>#3 Base Lipid Testing Association Follow-Up Inpatient Admissions</td>
<td>Regression Coefficient</td>
<td>-0.223 (&lt; 0.0005) -0.230 (&lt; 0.0005)</td>
<td>0.342 (&lt; 0.0005)</td>
</tr>
<tr>
<td>#4 Base Albumin Testing Association Follow-Up Inpatient Admissions</td>
<td>Regression Coefficient</td>
<td>-0.169 (0.008) -0.164 (0.002)</td>
<td>0.325 (&lt; 0.0005)</td>
</tr>
<tr>
<td>#5 Base A1C Testing Association Follow-Up Neuropathy Onset</td>
<td>Odds Ratio</td>
<td>.571 (0.001) .666 (0.008)</td>
<td>0.163 (&lt; 0.0005)</td>
</tr>
<tr>
<td>#6 Base Lipid Testing Association Follow-Up Neuropathy Onset</td>
<td>Odds Ratio</td>
<td>.614 (0.007) .654 (0.011)</td>
<td>0.165 (&lt; 0.0005)</td>
</tr>
</tbody>
</table>

*Table 4.30 Validation of Study Findings*

A discussion of these findings including study limitations, and policy implications are addressed in Chapter 5 Discussion.
CHAPTER FIVE – DISCUSSION

This empirical study supports the central hypothesis that preventive screening services improve outcomes for patients with Type 2 diabetes. This study seeks to fill a gap in the literature which does not provide empirical evidence as to which preventive screening services are most important in improving outcomes.

This study supports literature findings that patients with Type 2 diabetes receive suboptimal levels of preventive screening services. Findings from this research support the sub hypothesis that preventive screening services in the base year reduce follow-up period inpatient utilization. This study also supports the sub hypothesis that preventive screening services in the base year improve health outcomes by delaying the onset of microvascular disease in the follow-up period. Finally, as a contribution to the literature this study underscores the importance of lipids testing in improving outcomes for patients with Type 2 diabetes.

This chapter discusses these findings in three sections. The first section addresses managerial and policy implications of these study findings. The second section of this chapter discusses the limitations of this study and the third section calls for areas of continued research.

Managerial & Policy Implications

Costs: Patients with Type 2 diabetes are very costly ($512.68 per patient per month during the follow-up period of this study). Direct health care costs for patients in this study show a 30.1% increase in the 2 year follow-up period. This represents a rate of increase nearly twice the national health care inflationary rate for direct health care expenditures (Heffler, 2004).

The literature provides evidence that management and control of Type 2 diabetes and related complications requires multiple screening services and interventions. Despite such
evidence, studies show low rates of monitoring and control of the complications related to Type 2 diabetes (Wisdom, 1997, Saadine, 2002, Koro, 2004). This study supports the literature in reporting the health care system is not doing enough to monitor and control this chronic disease. Just 30% of this study population has both A1C and lipids screenings and just 10.5% of the study population has A1C, lipids and albumin screenings in the base year of this study.

Based on a number of factors including aging of the U.S. population, increasingly sedentary lifestyles and obesity, the prevalence of this disease is expected to increase over the next several decades. Further, this disease is becoming more common in younger patients. This increasing prevalence, younger age at onset and low rate of preventive screening is expected not only to increase costs within the health care system but will shift financial risk. In the absence of preventive screening services many patients are not aware they have Type 2 diabetes until complications occur. Care for patients that have already developed complications greatly increases costs. Based on onset in the elderly population the greatest financial burden of this disease in the past has been placed on the federal government through the Medicare program. As younger patients develop this disease, the health care system will incur greater costs related to treating such patients over longer periods of time. The financial burden of caring for such younger patients will shift from the federal government to commercial insurance and employers. Preventive screening services to delay the onset of cost-increasing complications of Type 2 diabetes are critical for all patients, but particularly for younger patients.

During the follow-up period of this study national direct health care costs rose 7.3% in 2001 and 9.3% in 2002 (Heffler, 2004). Consider the following patients examples from this study demonstrating large increases in costs for patients in this follow-up period. These patients do not have base year preventive screening services.
Patient id 3184 is a 63 year old female with base year costs of $13,081.42. Follow-up period costs of $54,836.05 represent more than a 3 fold increase in 2 years.

Patient id 238 is a 41 year old male with base year costs of $1,189.64. Follow-up period costs of $98,769.56 represent an 82 fold increase in 2 years.

Patient id 2544 is a 29 year old female with base year costs of $1,168.53. Follow-up period costs of $60,470.57 represent a 50 fold increase in 2 years.

While all three patients experience complications during this study that increase costs, these two younger patients carry the risk of repeating this pattern for a much longer period of time compared to the older patient. Further, in subsequent years the financial burden for care will be assumed by Medicare for the older patient. Commercial insurance (in this case Regence Blue Shield of Idaho) assumes the financial risk for these younger patients for several decades.

**Utilization:** This study has shown base year screening services are associated with decreases in follow-up period utilization of the Emergency Department (ED) and acute inpatient admissions. This finding is consistent with other studies that observed decreased rates of preventive screenings and reductions in ED visits and inpatient admissions for patients in opt-in disease management programs (Sidorov, 2002). The status of diabetes as a CHD risk equivalent to prior CHD events requires the health care system to set cardiovascular risk reduction as the primary for patients with Type 2 diabetes (Meigs, 2003). While lipid testing in the base year is present in just one-third of study participants, this study finding supports the importance of lipids testing in the care of Type 2 diabetic patients. Screening services beyond monitoring and control of glycemia (A1C) are associated with reductions in inpatient admissions in the follow-up period of this study.
While existing evidence supports multi-factorial preventive screening for controlling Type 2 diabetes, this study seeks to understand which screening services are the most effective for improving outcomes for patients with this disease. Of the four screening services in this analysis, lipids’ testing is associated with reductions in follow-up period ED visits, follow-up period inpatient admissions and improved health outcomes by delays in the onset of neuropathy. Disease management programs implemented by managed care organizations, health insurers and employers should be built or modified to reflect this finding. While all preventive services may be important to monitoring and controlling Type 2 diabetes, lipids’ testing is significantly associated with the greatest number of favorable outcomes for this study population. Health plans should systematically identify and notify patients with Type 2 diabetes who have not had lipids screening within the previous year that lipids’ testing is highly recommended to avoid complications due to the onset of such co-morbid conditions as neuropathy.

Inpatient care (emergency department visits and inpatient admissions) is a relatively rare event. Consider the continued example of patients from this study that does not have preventive screening services in the base year. These study participants do not have base year inpatient utilization but experience multiple events of inpatient care in the follow-up period.

- Patient id 238 has 4 emergency department (ED) visits and 2 inpatient admissions in the follow-up period.
- Patient id 2544 has 3 emergency department (ED) visits in the follow-up period.
- Patient id 3184 has 12 emergency department (ED) visits in the follow-up period.
While costs provide a fiscal view of this disease, inpatient utilization describes the pain and suffering of the patient. The patients in this example not only incur higher health care costs but utilize acute care services at higher rates than those without Type 2 diabetes.

Preventive screening services are designed to identify problems and allow providers to make corrections in treatment regimens before complications of this disease occur. Avoiding inpatient utilization (both ED and acute inpatient admissions) reduces suffering for the patient and allows the patient to continue daily routines. Inpatient utilization disrupts otherwise normal productive lifestyles of patients with chronic disease. It should be noted that a focus on preventive treatment and increased quality of life may not necessarily reduce direct health care costs. Monitoring and reducing cholesterol levels has been found to be costly (Hoerger, 2002). Increased costs represent treatment costs extended over a longer expected life.

**Health Outcomes:** This study reports A1C testing in the base year is associated with reductions in the risk of follow-up period neuropathy. This finding is consistent with multiple prospective studies (DCCT, UKPDS, WESDR) that associate reductions in microvascular risk with improved glycemic monitoring and control. Preventive screenings improve health outcomes for patients with Type 2 diabetes by identifying difficulties and adjusting treatment regimens before complications occur.

A coalition of partners including the Center for Medicare and Medicare Services (CMS), the American Diabetes Association (ADA) and National Committee for Quality Assurance (NCQA) has created the Diabetes Quality Improvement Project (DQIP) to develop a single set of measures to assess care delivered to patients with diabetes in the U.S. (Akinci, in press). This set of measures includes screenings analyzed in this study (A1C testing, lipids testing, albumin testing and eye exams). These process measures assess the percentage of people with diabetes
who had preventive screenings for lipids testing, albumin testing and eye exams in the previous 2 years (or within the previous year for some subsets of patients with diabetes). Results from this study associating improvements in health outcomes with A1C testing and lipids testing suggest even greater emphasis on lipids testing and control including annual lipids testing.

The example of 3 patients from this study continues. All 3 patients have no evidence of co-morbid disease at the end of the base year of this study. Further, all 3 patients have no preventive screenings in the base year.

- Patient id 238 (the 41 year old male) has a change in health status in the follow-up period with the presence of hypertension.
- Patient id 2544 (the 29 year old female) has a change in health status in the follow-up period with evidence of neuropathy and stroke.
- Patient id 3814 (the 63 year old female) has a change in health status in the follow-up period with presence of hypertension, dyslipidemia, cardiovascular disease and retinopathy.

While the absence of preventive screenings does not imply a casual effect with follow-up period onset of co-morbid diseases, such services are designed to alert providers to the potential for such difficulties. A system of screenings and interventions by health plan managers and health care providers are designed to improve the quality of life for chronically ill patients by delaying the onset of such co-morbid diseases.
Limitations

This analysis is exploratory and seeks to find answers from data. Knowledge Discovery in Databases (KDD) is an iterative process to find new knowledge from databases where dimensionality, complexity or the amount of data is prohibitively large for traditional analytic methods (Vesanto, 2000). A limitation of this study relates to the significance in meaning of information discovered during this process. This study uses this exploratory approach but then uses a quasi-experimental design to randomly place patient records into a study group and a validation cohort. The findings presented in this thesis are both statistically significant and pass this cross-validation test. This approach has allowed the development of statistically reliable predictive models that relate preventive screenings services with various utilization and health outcomes.

Retrospective analysis using administrative datasets allows for studies with large sample sizes and development of covariate variables to explain dependent variables. Administrative datasets serve as a proxy for describing the true medical condition of the patient. A limitation of this study is the unknown relationship between claims data medical conditions and outcomes of the patient. To address this concern this study has used industry standard algorithms for the clinical classification of administrative data (CCS by Agency for Healthcare Research and Quality).

Further, policy makers rely on the use of administrative datasets throughout the healthcare industry. The National Committee for Quality Assurance (NCQA) requires managed care organizations to use administrative datasets in reporting a number of utilization, cost and quality measures in reporting for the Health Plan Employer Data and Information Set (HEDIS). A coalition of 28 large American employers is in the process of creating hospital and physician
report cards on quality and cost measures for its two million members. And finally, the Center for Medicare and Medicaid Services provides large databases of administrative data upon which large numbers of health services research projects are completed every year.

Finally, it should be noted the source of claims data for this analysis is not directly controlled by the providing agency (Regency Blue Shield of Idaho). Thousands of providers serve as independent contractors submitting claims in a fee-for-service environment for payment processing. The completeness and accuracy of such claim submission is subject to a number of control mechanism including audits, fraud prosecution, peer review and profiling.

Further Research

The surprising finding from this study is the negative relationship observed between base year lipid testing and reductions in risk of neuropathy in the follow-up period. While lipid monitoring and control has been demonstrated to be strongly associated with reductions in macrovascular disease (Glasziou, 2002), this study finding suggests lipid control also plays a role in reducing microvascular complications related to Type 2 diabetes. Further research is needed in this area to understand the relationship between lipid testing and reductions in the onset of microvascular disease in patients with Type 2 diabetes.

The relationship between glycemic control and risk of macrovascular disease still puzzles many researchers (Turner, 1998). While diabetic patients are at an increased risk for macrovascular disease, monitoring and control of glycemia has not been demonstrated to reduce such risks. Patients with Type 2 diabetes have a large number of macrovascular related conditions including dyslipidemia, hypertension and obesity. Long-term prospective clinical trials are currently underway to understand this association (Abraira, 2003). Further studies
should continue to describe this link between the onset of microvascular and macrovascular
disease for patients with Type 2 diabetes.

The health care system is not doing enough to screen patients with Type 2 diabetes for
co-morbid disease. Similar to other studies (Wisdom, 1997; Saaddine, 2002; Koro, 2004) this
research has documented the low percentage of diabetic patients receiving preventive screening
services. Based on this limited number of patients receiving such services associations with
improvements in utilization and health outcomes are observed. Further research is required in
which similar outcomes are measured within a study population in which more patients receive
preventive screening services.

Additional research is required to understand the factors that drive cost and utilization for
patients with Type 2 diabetes. Study variables such as base period utilization, the measure of
Rbrvs for co-morbid care and all professional services and presence of co-morbid disease have
served as a proxy in this research for measuring severity of illness for each patient in the study
population. While this analysis provides statistically significant regression models, large
percentages of variance in cost, utilization and the onset of co-morbid disease are still
unexplained. Further research is needed to develop diabetes-specific factors that define the
severity and burden of illness of this disease. Controlling for the severity of illness within a
population is critical in assessing the impact of preventive screening services on improving cost,
utilization and health outcomes.

Finally, a greater emphasis must be placed on capturing data related to clinical outcomes
and for assessing the appropriateness of care delivered for patients with Type 2 diabetes.
Administrative data are the result of financial transactions within the health care system. For
example, this study identifies evidence of lipid screening based on CPT4 codes from a claim
form. Clinical information not available within this administrative dataset includes the laboratory values of such tests or action taken by the physician as a result of such tests (e.g. prescribing statins to control blood lipid levels). It is difficult to classify other services performed for this patient related to this screening (e.g. a referral to a cardiologist). Administrative data are visit-centric and do not reflect the complexity of many health care providers taking many actions to monitor and control chronic disease such as Type 2 diabetes. Indeed, this is a devastating disease with increasing costs and prevalence as well documented in this study. Investments in more robust and integrated financial and clinical databases are critical in developing standards of care by which health plan managers and health care providers can monitor and improve outcomes for patients with Type 2 diabetes in the future.
## APPENDIX A.1 – DEFINITION OF DIABETIC PATIENT

<table>
<thead>
<tr>
<th>ICD9CM Code</th>
<th>ICD9CM Code Short Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>DIABETES MELLITUS</td>
</tr>
<tr>
<td>2500</td>
<td>DIABETES MELLITUS WITHOUT MENTION OF COMPLICATION</td>
</tr>
<tr>
<td>25000</td>
<td>DIABETES MELLITUS WITHOUT MENTION OF COMPLICATION, TYPE II OR UNSPECIFIED T</td>
</tr>
<tr>
<td>25001</td>
<td>DIABETES MELLITUS WITHOUT MENTION OF COMPLICATION, TYPE I, NOT STATED AS UN</td>
</tr>
<tr>
<td>25002</td>
<td>DIABETES MELLITUS WITHOUT MENTION OF COMPLICATION, TYPE II OR UNSPECIFIED T</td>
</tr>
<tr>
<td>25003</td>
<td>DIABETES MELLITUS WITHOUT MENTION OF COMPLICATION, TYPE I, UNCONTROLLED</td>
</tr>
<tr>
<td>2501</td>
<td>DIABETES WITH KETOACIDOSIS</td>
</tr>
<tr>
<td>25010</td>
<td>DIABETES MELLITUS WITH KETOACIDOSIS TYPE II OR UNSPECIFIED TYPE, NOT STATED</td>
</tr>
<tr>
<td>25011</td>
<td>DIABETES MELLITUS WITH KETOACIDOSIS, TYPE I NOT STATED AS UNCONTROLLED</td>
</tr>
<tr>
<td>25012</td>
<td>DIABETES MELLITUS WITH KETOACIDOSIS, TYPE II OR UNSPECIFIED TYPE, UNCONTROL</td>
</tr>
<tr>
<td>25013</td>
<td>DIABETES MELLITUS WITH KETOACIDOSIS, TYPE I, UNCONTROLLED</td>
</tr>
<tr>
<td>2502</td>
<td>DIABETES WITH HYPEROSMOLARITY</td>
</tr>
<tr>
<td>25020</td>
<td>DIABETES MELLITUS WITH HYPEROSMOLARITY, TYPE II OR UNSPECIFIED TYPE, NOT STATED</td>
</tr>
<tr>
<td>25021</td>
<td>DIABETES MELLITUS WITH HYPEROSMOLARITY, TYPE I NOT STATED AS UNCONTROLLED</td>
</tr>
<tr>
<td>25022</td>
<td>DIABETES MELLITUS WITH HYPEROSMOLARITY, TYPE II OR UNSPECIFIED TYPE, UNCONTROL</td>
</tr>
<tr>
<td>2503</td>
<td>DIABETES WITH OTHER COMA</td>
</tr>
<tr>
<td>25030</td>
<td>DIABETES MELLITUS WITH OTHER COMA, TYPE II OR UNSPECIFIED TYPE, NOT STATED</td>
</tr>
<tr>
<td>25031</td>
<td>DIABETES MELLITUS WITH OTHER COMA, TYPE I NOT STATED AS UNCONTROLLED</td>
</tr>
<tr>
<td>25032</td>
<td>DIABETES MELLITUS WITH OTHER COMA, TYPE II OR UNSPECIFIED TYPE, UNCONTROL</td>
</tr>
<tr>
<td>25033</td>
<td>DIABETES MELLITUS WITH OTHER COMA, TYPE I, UNCONTROLLED</td>
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<tr>
<td>2504</td>
<td>DIABETES WITH RENAL MANIFESTATIONS</td>
</tr>
<tr>
<td>25040</td>
<td>DIABETES MELLITUS WITH RENAL MANIFESTATIONS, TYPE II OR UNSPECIFIED TYPE, N</td>
</tr>
<tr>
<td>25041</td>
<td>DIABETES MELLITUS WITH RENAL MANIFESTATIONS, TYPE I NOT STATED AS UNCONTROL</td>
</tr>
<tr>
<td>25042</td>
<td>DIABETES MELLITUS WITH RENAL MANIFESTATIONS, TYPE II OR UNSPECIFIED TYPE, U</td>
</tr>
<tr>
<td>25043</td>
<td>DIABETES MELLITUS WITH RENAL MANIFESTATIONS, TYPE I, UNCONTROLLED</td>
</tr>
<tr>
<td>2505</td>
<td>DIABETES WITH OPTHALMIC MANIFESTATIONS</td>
</tr>
<tr>
<td>25050</td>
<td>DIABETES MELLITUS WITH OPTHALMIC MANIFESTATIONS,</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>25051</td>
<td>Diabetes mellitus with ophthalmic manifestations, type I not stated as uncontrolled</td>
</tr>
<tr>
<td>25052</td>
<td>Diabetes mellitus with ophthalmic manifestations, type II or unspecified ty</td>
</tr>
<tr>
<td>25053</td>
<td>Diabetes mellitus with ophthalmic manifestations, type I, uncontrolled</td>
</tr>
<tr>
<td>25054</td>
<td>Diabetes with neurological manifestations</td>
</tr>
<tr>
<td>25055</td>
<td>Diabetes mellitus with neurological manifestations, type II or unspecified ty</td>
</tr>
<tr>
<td>25056</td>
<td>Diabetes mellitus with neurological manifestations, type I not stated as uncontrolled</td>
</tr>
<tr>
<td>25057</td>
<td>Diabetes mellitus with neurological manifestations, type II or unspecified ty</td>
</tr>
<tr>
<td>25058</td>
<td>Diabetes mellitus with neurological manifestations, type I, uncontrolled</td>
</tr>
<tr>
<td>25069</td>
<td>Diabetes with peripheral circulatory disorders</td>
</tr>
<tr>
<td>250610</td>
<td>Diabetes mellitus with peripheral circulatory disorders, type II or unspecified ty</td>
</tr>
<tr>
<td>250611</td>
<td>Diabetes mellitus with peripheral circulatory disorders, type I not stated</td>
</tr>
<tr>
<td>250612</td>
<td>Diabetes mellitus with peripheral circulatory disorders, type II or unspecified ty</td>
</tr>
<tr>
<td>250613</td>
<td>Diabetes mellitus with peripheral circulatory disorders, type I, uncontrolled</td>
</tr>
<tr>
<td>25070</td>
<td>Diabetes with other specified manifestations</td>
</tr>
<tr>
<td>250710</td>
<td>Diabetes mellitus with other specified manifestations, type II or unspecified ty</td>
</tr>
<tr>
<td>250711</td>
<td>Diabetes mellitus with other specified manifestations, type I not stated</td>
</tr>
<tr>
<td>250712</td>
<td>Diabetes mellitus with other specified manifestations, type II or unspecified ty</td>
</tr>
<tr>
<td>250713</td>
<td>Diabetes mellitus with other specified manifestations, type I, uncontrolled</td>
</tr>
<tr>
<td>25089</td>
<td>Diabetes with unspecified complication</td>
</tr>
<tr>
<td>250810</td>
<td>Diabetes mellitus with unspecified complication, type II or unspecified ty</td>
</tr>
<tr>
<td>250811</td>
<td>Diabetes mellitus with unspecified complication, type I not stated as uncontrolled</td>
</tr>
<tr>
<td>250812</td>
<td>Diabetes mellitus with unspecified complication, type II or unspecified ty</td>
</tr>
<tr>
<td>250813</td>
<td>Diabetes mellitus with unspecified complication, type I, uncontrolled</td>
</tr>
<tr>
<td>3572</td>
<td>Polyneuropathy in diabetes</td>
</tr>
<tr>
<td>3620</td>
<td>Diabetic retinopathy</td>
</tr>
<tr>
<td>36201</td>
<td>Background diabetic retinopathy</td>
</tr>
<tr>
<td>36202</td>
<td>Proliferative diabetic retinopathy</td>
</tr>
<tr>
<td>36641</td>
<td>Diabetic cataract</td>
</tr>
</tbody>
</table>
use diabetes
    go

-- Location: \PhD\Structures\
-- File:         Create segmentation Table.sql
-- Author:  Kenn Daratha
-- Date: 2/23/2004
-- Purpose: Creates a segmentation table with exclusion flags to segment
--         this dataset.
--
-- Last Run: 3/26/2004
-- Run Time: 1 Minute 28 Seconds

-- If the table already exists drop it.
if exists
    (select   table_name
    from     information_schema.tables
    where   table_name='segmentation')
drop table segmentation
    go

-- Create the table segmentation to identify the study groups of patients.
create table segmentation
    (    memberid int primary key,
         studyflag char(16)
    )
    go

-- Grant privileges to segmentation to public.
grant select on segmentation to public
    go

-- Select distinct members from medicalclaim and populate a default value
-- for the study flag. The definition of a diabetic member is provided by
-- diagnosis according to HEDIS Effectiveness of Care measure for Comprehensive
-- Diabetes Care.
insert segmentation
select distinct
    t1.memberid,
    'X'
from medicalclaim t1,
    diagnosis t2
where t1.claimid=t2.claimid and
t1.fromdate between '8/1/2000' and '7/31/2003' and
(t2.icd9code like '250%' or
 t2.icd9code in ('3572', '3620', '36201', '36202', '36641') )

go

-- Identify all patients with a diagnosis for diabetes mellitus in the base
-- year of this study.
update segmentation
set studyflag='BaseStudy'
from segmentation t1,
 medicalclaim t2,
 diagnosis t3
where t1.memberid=t2.memberid and
 t2.claimid=t3.claimid and
 t2.fromdate between '8/1/2000' and '7/31/2001' and
(t3.icd9code like '250%' or
 t3.icd9code in ('3572', '3620', '36201', '36202', '36641') )

go

-- If a patient did not have a medical claim indicating diabetes mellitus in
-- the base year, flag as not having a diabetic claim.
update segmentation
set studyflag='BaseNotDiabetic'
where studyflag='X'
go

-- Flag any cost outliers in the base year of this study. A cost outlier is
-- defined as a mean total cost more than 2 standard deviations above the mean.
declare @outlier_amount numeric(8,2)
select @outlier_amount =
 (select avg(t1.basedollars) + 2*(stdev(t1.basedollars))
 from patient t1
 where t1.firstdate between '8/1/2000' and '7/31/2001')
update segmentation
set studyflag='BaseCostOutlier'
from patient t1,
 segmentation t2
where t1.memberid=t2.memberid and
 t2.studyflag='BaseStudy' and
 t1.basedollars > @outlier_amount

go

-- Flag any medicare patients in the base study period to remove
-- from this analysis.
update segmentation
set studyflag='BaseMedicare'
from medicaremember t1,
    segmentation t2
where t1.memberid=t2.memberid and
    t2.studyflag='BaseStudy'
go

-- Flag any patients without drug claims in the base study year to remove
-- from cost analysis.
update segmentation
set studyflag='BaseNoDrug'
from segmentation t1
where t1.studyflag='BaseStudy' and
    (not exists
        (select 1
            from drugclaim t2
            where t1.memberid=t2.memberid and
                t2.fromdate between '8/1/2000' and '7/31/2001')
    )
go
APPENDIX B.1 – CREATE PATIENT-SPECIFIC FACTORS

use diabetes

go

-- Location: \PhD\Analysis\Study
-- File: Create analysis_factors Table.sql
-- Author: Kenn B. Daratha
-- Date: 2-24-2004
--
-- Purpose: Creates a table based on patient id with
-- variables used in this doctoral research.
--
-- Run Time: 17 Minutes 05 Seconds
-- Last Run: 3/30/2004

-- If the process control table already exists drop it.
if exists
    (select   table_name
     from     information_schema.tables
     where   table_name='processcontrol')
drop table processcontrol

-- Create a process control table to track start and end time.
create table processcontrol
    ( task  char(10),
      starttime datetime,
      endtime   datetime)

insert processcontrol values ('factors',null, null)

update processcontrol
set      starttime=(select getdate())
where    task='factors'

-- If the table already exists drop it.
if exists
    (select   table_name
     from     information_schema.tables
     where   table_name='analysis_factors')
drop table analysis_factors
-- Create the table analysis_factors
create table analysis_factors
(
    memberid int primary key,
    age int,
    gender int,
    chflag int,
    chrbrvs numeric(5,2),
    macflag int,
    hypertension int,
    dyslipidemia int,
    cardiac int,
    stroke int,
    micflag int,
    renal int,
    esrd int,
    retinal int,
    blind int,
    neuro int,
    amputation int,
    depression int
)

-- Grant privileges to analysis_factors to public.
grant select on analysis_factors to public

go

-- If the table already exists drop it.
if exists
    (select table_name
     from information_schema.tables
     where table_name='rulelog')
    drop table rulelog

go

-- Create the rulelog table.
create table rulelog
(
    memberid int,
    ruleid char(4),
    ruledate smalldatetime,
    visittype char(1),
    compflag char(12),
    rbrvs numeric(5,2),
    period char(6)
)
GO
-- Grant privileges on rulelog to public.
grant select on rulelog to public
GO

-- Initially populate the analysis table with default values.
INSERT INTO analysis_factors
SELECT DISTINCT t1.memberid,
-1,
-1,
-1,
-1,
-1,
-1,
-1,
-1,
-1,
-1,
-1,
-1,
-1,
-1
FROM segmentation t1
WHERE t1.studyflag in ('BaseStudy', 'BaseNoDrug')
GO

DECLARE @memberid INT
DECLARE @firstdt DATETIME
DECLARE @lastdt DATETIME
DECLARE @period CHAR(6)

DECLARE analysis_cursor CURSOR
FOR

SELECT t1.memberid,
       t2.firstdt,
       DATEADD(dd, 364, t2.firstdt),
       'base'
FROM segmentation t1,
     patient t2
where t1.memberid=t2.memberid and
t1.studyflag in ('BaseStudy', 'BaseNoDrug')
order by 1

open   analysis_cursor
fetch next from analysis_cursor
into   @memberid, @firstdt, @lastdt, @period

while @@fetch_status=0
begin
   -- Determine the age for this patient at the end of the base year
   declare @age73101 int
   exec  proc_age @memberid, '7/31/2001', @age=@age73101 output
   update analysis_factors
   set   age = @age73101
   where memberid=@memberid

   -- Determine the gender for this patient
   declare @sex int
   exec  proc_gender @memberid, @gender=@sex output
   update analysis_factors
   set   gender=@sex
   where memberid=@memberid

   -- Determine the hypertension status for this patient at the end of the base year
   declare @hypflag int
   select @hypflag=0
   exec  proc_hypertension  @memberid,
             @firstdt,
             @lastdt,
             @period,
             @hytenflag=@hypflag output
   update analysis_factors
   set   hypertension=@hypflag
   where memberid=@memberid

   -- Determine the dyslipidemia status for this patient at the end of the base year
   declare @dysflag int
   select @dysflag=0
   exec  proc_dyslipidemia  @memberid,
             @firstdt,
             @lastdt,
             @period,
             @dyslipflag=@dysflag output
   update analysis_factors
   set   dyslipidemia=@dysflag
where memberid=@memberid

-- Determine the cardiac status for this patient at the end of the base year
declare @carflag int
select @carflag=0
exec proc_cardiac @memberid,
                @firstdt,
                @lastdt,
                @period,
                @cardflag=@carflag output
update analysis_factors
set cardiac=@carflag
where memberid=@memberid

-- Determine the stroke status for this patient at the end of the base year
declare @stkflag int
select @stkflag=0
exec proc_stroke @memberid,
                @firstdt,
                @lastdt,
                @period,
                @strokeflag=@stkflag output
update analysis_factors
set stroke=@stkflag
where memberid=@memberid

-- Determine the renal status for this patient at the end of the base year
declare @renflag int
select @renflag=0
declare @esrflag int
select @esrflag=0
exec proc_renal @memberid,
                @firstdt,
                @lastdt,
                @period,
                @renalflag=@renflag output,
                @esrdflag=@esrflag output
update analysis_factors
set renal=@renflag
where memberid=@memberid

update analysis_factors
set esrd=@esrflag
where memberid=@memberid

-- Determine the retinal status for this patient at the end of the base year
declare @retflag int
select @retflag=0
declare @bliflag int
select @bliflag=0
exec proc_retinal @memberid,
@firstdt,
@lastdt,
@period,
@retinalflag=@retflag output,
@blindflag=@bliflag output
update analysis_factors
set retinal=@retflag
where memberid=@memberid
update analysis_factors
set blind=@bliflag
where memberid=@memberid

-- Determine the neurological status for this patient at the end of the base year
declare @neuflag int
select @neuflag=0
declare @ampflag int
select @ampflag=0
exec proc_neuro @memberid,
@firstdt,
@lastdt,
@period,
@neuroflag=@neuflag output,
@amputflag=@ampflag output
update analysis_factors
set neuro=@neuflag
where memberid=@memberid
update analysis_factors
set amputation=@ampflag
where memberid=@memberid

-- Determine the aggregate comorbidity status for this patient at the end of the base study year. If the patient is hypertensive, has dyslipidemia, has comorbidities of cardiac, renal, retinal, neurological or stroke, this aggregate comorbidity flag is set.
if (@hypflag=1 or @dysflag=1 or @carflag=1 or @stkflag=1)
   @renflag=1 or @retflag=1 or @neuflag=1 or
   @esrflag=1 or @bliflag=1 or @ampflag=1)
begin

update analysis_factors
set chflag=1
where memberid=@memberid
end
else
begin
update analysis_factors
set chflag=0
where memberid=@memberid
end

-- Determine the depression status for this patient at the end of the base year
declare @depflag int
select @depflag=0
exec proc_depression @memberid, @firstdt, @lastdt, @period,
@depressflag=@depflag output
update analysis_factors
set depression=@depflag
where memberid=@memberid

-- Get the next patient to process
fetch next from analysis_cursor into @memberid, @firstdt, @lastdt, @period
end

close analysis_cursor
deallocate analysis_cursor

update processcontrol
set endtime=(select getdate())
where task='factors'
go
APPENDIX B.2 – STORED PROCEDURE AGE

use diabetes

-- Location: PhD\Structure\Stored Procedures
-- File: proc_age.sql
-- Author: Kenn B. Daratha
-- Date: 1-27-2004
--
-- Purpose: Creates a stored procedure to input the parameters of memberid and the
-- age as of date and return the age of the patient at that date.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_age' AND type = 'P')
    DROP PROCEDURE proc_age

CREATE PROCEDURE proc_age
    @member int,
    @agedate datetime,
    @age int output
AS
    select @age =
        (select distinct
            datediff(yy,t1.birthdate,@agedate)
        from patient t1
        where t1.memberid=@member)

go
APPENDIX B.3 – STORED PROCEDURE GENDER

use diabetes

go

-- Location: PhD\Structures\Stored Procedures
-- File: proc_gender.sql
-- Author: Kenn B. Daratha
-- Date: 1-27-2004
--
-- Purpose: Creates a stored procedure to input the parameter of memberid and return
-- the gender of the patient. If a 0 is returned the patient is female. If
-- a 1 is returned the patient is male.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_gender' AND type = 'P')
    DROP PROCEDURE proc_gender

go

CREATE PROCEDURE proc_gender
    @member  int,
    @gender  tinyint output
AS
declare @tgender char(10)
select @tgender =
    (select distinct
        t1.gender
    from patient t1
    where t1.memberid=@member)

if @tgender='female'
    begin
        select @gender=0
    end
else
    begin
        select @gender=1
    end

go
use diabetes

-- Location: PhD\Structures\Stored Procedures
-- File: proc_hypertension.sql
-- Author: Kenn B. Daratha
-- Date: 2-24-2004

-- Purpose: Creates a stored procedure to input the parameters of memberid and the
diagnosis period date range and return the hypertension status of the
patient. A '0' indicates no and a '1' indicates yes for comorbidities.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_hypertension' AND type = 'P')
    DROP PROCEDURE proc_hypertension

CREATE PROCEDURE proc_hypertension
    @member int,
    @startdate datetime,
    @enddate datetime,
    @period char(6),
    @hytenflag int output
AS
    -- Check for a medical claim for 98 and 99 - hypertension
    declare @99_flag char(1)

    select @99_flag =
    (select max('T')
        from medicalclaim t1,
            diagnosis t2,
            ccs_category t3
        where t1.memberid=@member and
            t1.claimid=t2.claimid and
            t2.icd9code=t3.icd9code and
            t1.fromdate between @startdate and @enddate and
            t3.ccs_category in (98,99) and
            t1.claimtype='h' and
            (t1cptcode between '99201' and '99357' or
                t1 cptcode between '99381' and '99429' or
                t1.cptcode = '99499'))
if @99_flag='T'
  begin
    insert rulelog
    select distinct
      t1.memberid,
      t3.ccs_category,
      t1.fromdate,
      'p',
      'hypertension',
      t4.rbrvs,
      @period
    from medicalclaim t1,
        diagnosis t2,
        ccs_category t3,
        rbrvs t4
    where t1.memberid=@member and
          t1.claimid=t2.claimid and
          t2.icd9code=t3.icd9code and
          t1.cptcode=t4.cptcode and
          t1.fromdate between @startdate and @enddate and
          t3.ccs_category in (98,99) and
          t1.claimtype='h' and
          (t1.cptcode between '99201' and '99357' or
           t1.cptcode between '99381' and '99429')
  end
if @99_flag = 'T'
  begin
    select @hytenflag=1
  end
else
  begin
    select @hytenflag=0
  end
go
APPENDIX B.5 – STORED PROCEDURE DYSLIPIDEMIA

use diabetes

go

-- Location:  PhD\Structures\Stored Procedures
-- File:      proc_dyslipidemia.sql
-- Author:   Kenn B. Daratha
-- Date:     2-24-2004
--
-- Purpose:  Creates a stored procedure to input the parameters of memberid and the
diagnosis period date range and return the dyslipidemia status of the
patient. A '0' indicates no and a '1' indicates yes for comorbidities.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_dyslipidemia' AND type = 'P')
    DROP PROCEDURE proc_dyslipidemia

go

CREATE PROCEDURE proc_dyslipidemia
    @member   int,
    @startdate datetime,
    @enddate  datetime,
    @period   char(6),
    @dyslipflag int output
AS
-- Check for a medical claim for 53 - disorders of lipid metabolism
declare @53_flag char(1)
select @53_flag =
    (select max('T')
        from medicalclaim t1,
            diagnosis t2,
            ccs_category t3
        where t1.memberid=@member and
            t1.claimid=t2.claimid and
            t2.icd9code=t3.icd9code and
            t1.fromdate between @startdate and @enddate and
            t3.ccs_category =53 and
            t1.claimtype='h' and
            (t1.cptcode between '99201' and '99357' or
                t1.cptcode between '99381' and '99429' or
                t1.cptcode = '99499')
    )
if @53_flag='T'
begin
    insert rulelog
    select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'p',
'dyslipidemia',
t4.rbrvs,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3,
rbrvs t4
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.cptcode=t4.cptcode and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 53 and
t1.claimtype='h' and
(t1.cptcode between '99201' and '99357' or
t1.cptcode between '99381' and '99429')
end

if (@53_flag = 'T')
begin
    select @dyslipflag=1
end
else
begin
    select @dyslipflag=0
end
go
APPENDIX B.6 – STORED PROCEDURE CARDIAC

use diabetes
  go

-- Location: PhD\Structures\Stored Procedures
-- File: proc_cardiac.sql
-- Author: Kenn B. Daratha
-- Date: 2-23-2004
--
-- Purpose: Creates a stored procedure to input the parameters of memberid and the
diagnosis period date range and return the cardiac status of the
patient. A '0' indicates no and a '1' indicates yes for comorbidities.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_cardiac' AND type = 'P')
DROP PROCEDURE proc_cardiac
  go

CREATE PROCEDURE proc_cardiac
    @member int,
    @startdate datetime,
    @enddate datetime,
    @period char(6),
    @cardflag int output
AS
-- Check for a medical claim for 97 - pericarditis (cardiomyopathy)
declare @97_flag char(1)

select @97_flag =
    (select max('T')
      from medicalclaim t1,
           diagnosis t2,
           ccs_category t3
      where t1.memberid=@member and
      t1.claimid=t2.claimid and
      t2.icd9code=t3.icd9code and
      t1.fromdate between @startdate and @enddate and
      t3.ccs_category=97 and
      t2.icd9code between '425' and '4290' and
      (t1.claimtype='u' or
       (t1.claimtype='h' and
        (t1.cptcode between '99201' and '99357' or
         t1.cptcode between '99381' and '99429' or
         t1.cptcode = '99499'))
    )
if @97_flag='T'

begin

    insert rulelog
    select distinct
        t1.memberid,
        t3.ccs_category,
        t1.fromdate,
        'p',
        'cvd',
        t4.rbrvs,
        @period
    from medicalclaim t1,
        diagnosis t2,
        ccs_category t3,
        rbrvs t4
    where t1.memberid=@member and
        t1.claimid=t2.claimid and
        t2.icd9code=t3.icd9code and
        t1.cptcode=t4.cptcode and
        t1.fromdate between @startdate and @enddate and
        t3.ccs_category=97 and
        t2.icd9code between '425' and '4290' and
        t1.claimtype='h' and
        (t1.cptcode between '99201' and '99357' or
        t1.cptcode between '99381' and '99429')

insert rulelog
select distinct
    t1.memberid,
    t3.ccs_category,
    t1.fromdate,
    'o',
    'cvd',
    0,
    @period
from medicalclaim t1,
    diagnosis t2,
    ccs_category t3
where t1.memberid=@member and
    t1.claimid=t2.claimid and
    t2.icd9code=t3.icd9code and
    t1.cptcode=t4.cptcode and
t1.fromdate between @startdate and @enddate and
t3.ccs_category=97 and
t2.icd9code between '425' and '4290' and
t1.claimtype='u' and not exists
(select 1
from medicalclaim t2
where t2.memberid=@member and
      t1.fromdate=t2.fromdate and
      t2.claimtype='u' and
      (t1.revcode between '00100' and '00160' or
       t1.revcode between '00200' and '00214') )

insert rulelog
select distinct
  t1.memberid,
  t3.ccs_category,
  t1.fromdate,
  'i',
  'cvd',
  0,
  @period
from medicalclaim t1,
     diagnosis t2,
     ccs_category t3
where t1.memberid=@member and
      t1.claimid=t2.claimid and
      t2.icd9code=t3.icd9code and
      t1.fromdate between @startdate and @enddate and
      t3.ccs_category=97 and
      t2.icd9code between '425' and '4290' and
      t1.claimtype='u' and
      (t1.revcode between '00100' and '00160' or
       t1.revcode between '00200' and '00214')

-- Check for a medical claim for 100 - acute myocardial infarction
declare @100_flag char(1)

select @100_flag =
(select max('T')
from medicalclaim t1,
     diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fomdate between @startdate and @enddate and
t3.ccs_category=100 and
(t1.claimtype='u' or
 (t1.claimtype='h' and
  (t1.cptcode between '99201' and '99357' or
   t1.cptcode between '99381' and '99429' or
   t1.cptcode = '99499')
  )
 )
)
if @100_flag='T'
begin
insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fomdate,
'l'
'p',
'cvd',
t4.rbrvs,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3,
rbrvs t4
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.cptcode=t4.cptcode and
t1.fomdate between @startdate and @enddate and
t3.ccs_category=100 and
t1.claimtype='h' and
(t1.cptcode between '99201' and '99357' or
 t1.cptcode between '99381' and '99429')
insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate, 'o', 'cvd', 0, @period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category=100 and
t1.claimtype='u' and not exists
(select 1
from medicalclaim t2
where t2.memberid=@member and
t1.fromdate=t2.fromdate and
t2.claimtype='u' and
(t1.revcode between '00100' and '00160' or
t1.revcode between '00200' and '00214')
)
insert rulelog
select distinct t1.memberid,
t3.ccs_category,
t1.fromdate, 'i', 'cvd', 0, @period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category=100 and
t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
t1.revcode between '00200' and '00214')
)
end

-- Check for a medical claim for 101 - coronary atherosclerosis and other heart disease
declare @101_flag  char(1)

select @101_flag =
    (select max('T')
     from medicalclaim t1,
             diagnosis t2,
             ccs_category t3
     where t1.memberid=@member and
           t1.claimid=t2.claimid and
           t2.icd9code=t3.icd9code and
           t1.from date between @startdate and @enddate and
           t3.ccs_category=101 and
           (t1.claimtype='u' or
            (t1.claimtype='h' and
             (t1.cptcode between '99201' and '99357' or
              t1.cptcode between '99381' and '99429' or
              t1.cptcode = '99499'))
     )
    )

if @101_flag='T'
begin
    insert rulelog
    select distinct
        t1.memberid,
        t3.ccs_category,
        t1.from date,
        'p',
        'cvd',
        t4.rbrvs,
        @period
    from medicalclaim t1,
         diagnosis t2,
         ccs_category t3,
         rbrvs t4
    where t1.memberid=@member and
          t1.claimid=t2.claimid and
          t2.icd9code=t3.icd9code and
          t1.cptcode=t4.cptcode and
t1.fromdate between @startdate and @enddate and
t3.ccs_category=101 and
t1.claimtype='h' and
(t1cptcode between '99201' and '99357' or
t1.cptcode between '99381' and '99429')

insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'o',
'cvd',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.cla imid=t2.claimid and
2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category=101 and
t1.claimtype='u' and not exists
(select 1
from medicalclaim t2
where t2.memberid=@member and
t1.fromdate=t2.fromdate and
t2.claimtype='u' and
(t1.revcode between '00100' and '00160' or
t1.revcode between '00200' and '00214')

insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
i',
'cvd',
0,
@period
from medicalclaim t1,
```
diagnosis t2,
css_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.css_category=101 and
t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
t1.revcode between '00200' and '00214')
end

-- Check for a medical claim for 107 - Cardiac Arrest
declare @107_flag char(1)
select @107_flag =
(select max('T')
from   medicalclaim t1,
diagnosis t2,
css_category t3
where   t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.css_category=107 and
t2.icd9code = '4275' and
(t1.claimtype='u' or
 (t1.claimtype='h' and
 (t1cptcode between '99201' and '99357' or
t1.cptcode between '99381' and '99429' or
t1.cptcode = '99499'))
)
)
if @107_flag='T'
begin
insert rulelog
select distinct
t1.memberid,
t3.css_category,
t1.fromdate,
```
'p',
'cvd',
t4.rbrvs,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3,
rbrvs t4
where t1.memberid=@member and
  t1.claimid=t2.claimid and
  t2.icd9code=t3.icd9code and
  t1cptcode=t4.cptcode and
  t1.fromdate between @startdate and @enddate and
  t3.ccs_category=107 and
  t2.icd9code = '4275' and
  t1.claimtype='h' and
  (t1.cptcode between '99201' and '99357' or
   t1.cptcode between '99381' and '99429')

insert rulelog
select distinct
  t1.memberid,
  t3.ccs_category,
  t1.fromdate,
  'o',
  'cvd',
  0,
  @period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
  t1.claimid=t2.claimid and
  t2.icd9code=t3.icd9code and
  t1.fromdate between @startdate and @enddate and
  t3.ccs_category=107 and
  t2.icd9code = '4275' and
  t1.claimtype='u' and not exists
  (select 1
   from medicalclaim t2
   where t2.memberid=@member and
     t1.fromdate=t2.fromdate and
   t1.claimtype='u' and not exists
  )
t2.claimtype='u' and
(t1.revcode between '00100' and '00160' or
t1.revcode between '00200' and '00214') )

insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'i',
'cvd',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category=107 and
t2.icd9code = '4275' and
t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
t1.revcode between '00200' and '00214')

end

-- Check for a medical claim for 108 - Congestive Heart Failure
declare @108_flag char(1)

select @108_flag =
(select max('T')
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category=108 and
t2.icd9code = '4275' and
t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
t1.revcode between '00200' and '00214')

end
if @108_flag='T'
begin
  insert rulelog
  select distinct
    t1.memberid,
    t3.ccs_category,
    t1.from_date,
    'p',
    'cvd',
    t4.rbrvs,
    @period
  from medicalclaim t1,
    diagnosis t2,
    ccs_category t3,
    rbrvs t4
  where t1.memberid=@member and
        t1.claimid=t2.claimid and
        t2.icd9code=t3.icd9code and
        t1.cptcode=t4.cptcode and
        t1.from_date between @startdate and @enddate and
        t3.ccs_category=108 and
        t1.claimtype='h' and
        (t1.cptcode between '99201' and '99357' or
         t1.cptcode between '99381' and '99429')

  insert rulelog
  select distinct
    t1.memberid,
    t3.ccs_category,
    t1.from_date,
    'o',
    'cvd',
    0,
    @period
  from medicalclaim t1,
    diagnosis t2,
    ccs_category t3
  where t1.memberid=@member and
        t1.claimid=t2.claimid and
        t2.icd9code=t3.icd9code and

t1.fromdate between @startdate and @enddate and
t3.ccs_category=108 and
t1.claimtype='u' and not exists
  (select 1
   from medicalclaim t2
   where t2.memberid=@member and
   t1.fromdate=t2.fromdate and
   t2.claimtype='u' and
   (t1.revcode between '00100' and '00160' or
    t1.revcode between '00200' and '00214') )
insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'1',
'cvd',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
 t1.revcode between '00200' and '00214')
end
if ( @97_flag = 'T' or @100_flag = 'T' or @101_flag = 'T' or
 @107_flag = 'T' or @108_flag = 'T')
begin
  select @cardflag = 1
end
else
begin
  select @cardflag = 0
end

go
use diabetes

go

-- Location: PhD\Structures\Stored Procedures
-- File: proc_stroke.sql
-- Author: Kenn B. Daratha
-- Date: 2-24-2004
--
-- Purpose: Creates a stored procedure to input the parameters of memberid and the
-- diagnosis period date range and return the stroke status of the
-- patient. A '0' indicates no and a '1' indicates yes for comorbidities.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_stroke' AND type = 'P')
    DROP PROCEDURE proc_stroke

GO

CREATE PROCEDURE proc_stroke
    @member int,
    @startdate datetime,
    @enddate datetime,
    @period char(6),
    @strokeflag int output
AS
    -- Check for a medical claim for 109 - acute cerebrovascular disease
    declare @109_flag char(1)

    select @109_flag =
        (select max('T')
         from medicalclaim t1,
             diagnosis t2,
             ccs_category t3
         where t1.memberid=@member and
             t1.claimid=t2.claimid and
             t2.icd9code=t3.icd9code and
             t1.fromdate between @startdate and @enddate and
             t3.ccs_category = 109 and
             (t1.claimtype='u' or
             (t1.claimtype='h' and
                 (t1.cptcode between '99201' and '99357' or
                 t1.cptcode between '99381' and '99429' or
                 t1.cptcode = '99499'))


if @109_flag='T'
begin
  insert rulelog
  select distinct
      t1.memberid,
      t3.ccs_category,
      t1.fromdate,
      'p',
      'stroke',
      t4.rbrvs,
      @period
  from medicalclaim t1,
       diagnosis t2,
       ccs_category t3,
       rbrvs t4
  where t1.memberid=@member and
        t1.cla imid=t2.claimid and
        t2.icd9code=t3.icd9code and
        t1cptcode=t4.cptcode and
        t1.fromdate between @startdate and @enddate and
        t3.ccs_category = 109 and
        t1.claimtype='h' and
        (t1.cptcode between '99201' and '99357' or
         t1.cptcode between '99381' and '99429')
  )
  )
  )
if @109_flag='T'
begin
  insert rulelog
  select distinct
      t1.memberid,
      t3.ccs_category,
      t1.fromdate,
      'o',
      'stroke',
      0,
      @period
  from medicalclaim t1,
       diagnosis t2,
       ccs_category t3
  where t1.memberid=@member and
        t1.cla imid=t2.claimid and
        t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 109 and
t1.claimtype='u' and not exists
(select 1
from medicalclaim t2
where t2.memberid=@member and
t1.fromdate=t2.fromdate and

t2.claimtype='u' and
(t1.revcode between '00100' and '00160' or
 t1.revcode between '00200' and '00214') )

insert rulelog
select distinct
 t1.memberid, 
t3.ccs_category, 
t1.fromdate,
'1',
'stroke',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and

t1.fromdate between @startdate and @enddate and
t3.ccs_category = 109 and
t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
 t1.revcode between '00200' and '00214')
end

-- Check for a medical claim for 110 - occlusion or stenosis of precerebral arteries
declare @110_flag char(1)

select @110_flag =
(select max('T')
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and

t1.fromdate between @startdate and @enddate and
t3.ccs_category = 109 and
t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
 t1.revcode between '00200' and '00214')
end

180
t1.claimid=t2.claimid and
  t2.icd9code=t3.icd9code and

  t1.fromdate between @startdate and @enddate and
  t3.ccs_category = 110 and
  (t1.claimtype='u' or
   (t1.claimtype='h' and
    (t1.cptcode between '99201' and '99357' or
     t1.cptcode between '99381' and '99429' or
     t1.cptcode = '99499'))

  if @110_flag='T'
  begin
    insert rulelog
    select distinct
      t1.memberid, t3.ccs_category, t1.fromdate, 'p', 'stroke', t4.rbrvs, @period
    from medicalclaim t1,
        diagnosis t2,
        ccs_category t3,
        rbrvs t4
    where t1.memberid=@member and
      t1.claimid=t2.claimid and
      t2.icd9code=t3.icd9code and
      t1.cptcode=t4.cptcode and
      t1.fromdate between @startdate and @enddate and
      t3.ccs_category = 110 and
      t1.claimtype='h' and
      (t1.cptcode between '99201' and '99357' or
       t1.cptcode between '99381' and '99429')
  end

insert rulelog
select distinct
  t1.memberid, t3.ccs_category, t1.fromdate, 'o',
'stroke',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 110 and

t1.claimtype='u' and not exists
(select 1
from medicalclaim t2
where t2.memberid=@member and
t1.fromdate=t2.fromdate and
t2.claimtype='u' and
(t1.revcode between '00100' and '00160' or
t1.revcode between '00200' and '00214'))

insert rulelog
select distinct
    t1.memberid,
    t3.ccs_category,
    t1.fromdate,
    'i',
    'stroke',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 110 and
    t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
t1.revcode between '00200' and '00214'))
end
-- Check for a medical claim for 111 - other and ill-defined cerebrovascular disease
declare @111_flag char(1)

select @111_flag =
    (select max('T')
    from medicalclaim t1,
        diagnosis t2,
        ccs_category t3
    where t1.memberid=@member and
        t1.claimid=t2.claimid and
        t2.icd9code=t3.icd9code and
        t1.fromdate between @startdate and @enddate and
        t3.ccs_category = 111 and
        (t1.claimtype='u' or
        (t1.claimtype='h' and
        (t1cptcode between '99201' and '99357' or
            t1cptcode between '99381' and '99429' or
            t1cptcode = '99499'))
    )
)

if @111_flag='T'
begin
    insert rulelog
    select distinct
        t1.memberid,
        t3.ccs_category,
        t1.fromdate,
        'p',
        'stroke',
        t4.rbrvs,
        @period
    from medicalclaim t1,
        diagnosis t2,
        ccs_category t3,
        rbrvs t4
    where t1.memberid=@member and
        t1.claimid=t2.claimid and
        t2.icd9code=t3.icd9code and
        t1.cptcode=t4.cptcode and
        t1.fromdate between @startdate and @enddate and
        t3.ccs_category = 111 and
(t1.cptcode between '99201' and '99357' or
t1.cptcode between '99381' and '99429')

insert rulelog
select distinct
  t1.memberid,
  t3.ccs_category,
  t1.fromdate,
  'o',
  'stroke',
  0,
  @period
from medicalclaim t1,
  diagnosis t2,
  ccs_category t3
where t1.memberid=@member and
  t1.claImid=t2.claimid and
  t2.icd9code=t3.icd9code and
  t1.fromdate between @startdate and @enddate and
  t3.ccs_category = 111 and
  t1.claimtype='u' and not exists
  (select 1
   from medicalclaim t2
   where t2.memberid=@member and
     t2.fromdate=t1.fromdate and
     t2.claimtype='u' and
     (t1.revcode between '00100' and '00160' or
      t1.revcode between '00200' and '00214')
  )

insert rulelog
select distinct
  t1.memberid,
  t3.ccs_category,
  t1.fromdate,
  'i',
  'stroke',
  0,
  @period
from medicalclaim t1,
  diagnosis t2,
  ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 111 and
t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
t1.revcode between '00200' and '00214')

end

-- Check for a medical claim for 112 - transient cerebral ischemia
declare @112_flag char(1)
select @112_flag =
(select max('T')
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 112 and
(t1.claimtype='u' or
 (t1.claimtype='h' and
  (t1.cptcode between '99201' and '99357' or
   t1.cptcode between '99381' and '99429' or
   t1.cptcode = '99499'))
  )
)
if @112_flag='T'
begi
  insert rulelog
  select distinct
    t1.memberid,
    t3.ccs_category,
    t1.fromdate,
    'p',
    'stroke',
    t4.rbrvs,
    @period
  from medicalclaim t1,

185
```
diagnosis t2,
ccs_category t3,
rbrvs t4
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.cptcode=t4.cptcode and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 112 and
t1.claimtype='h' and
(t1.cptcode between '99201' and '99357' or
t1.cptcode between '99381' and '99429')

insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'o','stroke',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 112 and
t1.claimtype='u' and not exists
(select 1
from    medicalclaim t2
where    t2.memberid=@member and
t1.fromdate=t2.fromdate and
(t2.revcode between '00100' and '00160' or
 t2.revcode between '00200' and '00214')
)

insert rulelog
select distinct
t1.memberid,
186
```
t3.ccs_category,
t1.fromdate,
'i',
'stroke',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
    t1.claimid=t2.claimid and
    t2.icd9code=t3.icd9code and
    t1.fromdate between @startdate and @enddate and
    t3.ccs_category = 112 and
    t1.claimtype='u' and
    (t1.revcode between '00100' and '00160' or
     t1.revcode between '00200' and '00214')
end

-- Check for a medical claim for 113 - late effects of cerebrovascular disease
declare @113_flag char(1)

select @113_flag =
    (select max('T')
    from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
    t1.claimid=t2.claimid and
    t2.icd9code=t3.icd9code and
    t1.fromdate between @startdate and @enddate and
    t3.ccs_category = 113 and
    (t1.claimtype='u' or
     (t1.claimtype='h' and
      (t1 cptcode between '99201' and '99357' or
       t1.cptcode between '99381' and '99429' or
       t1.cptcode = '99499'))
    )
    )
if @113_flag = 'T'
begin

insert rulelog
select distinct
  t1.memberid,
  t3.ccs_category,
  t1.fromdate,
  'p',
  'stroke',
  t4.rbrvs,
  @period
from medicalclaim t1,
     diagnosis t2,
     ccs_category t3,
     rbrvs t4
where t1.memberid=@member and
      t1.claimid=t2.claimid and
      t2.icd9code=t3.icd9code and
      t1.cptcode=t4.cptcode and
      t1.fromdate between @startdate and @enddate and
      t3.ccs_category = 113 and
      t1.claimtype='h' and
      (t1.cptcode between '99201' and '99357' or
      t1.cptcode between '99381' and '99429')

insert rulelog
select distinct
  t1.memberid,
  t3.ccs_category,
  t1.fromdate,
  'o',
  'stroke',
  0,
  @period
from medicalclaim t1,
     diagnosis t2,
     ccs_category t3
where t1.memberid=@member and
      t1.claimid=t2.claimid and
      t2.icd9code=t3.icd9code and
      t1.fromdate between @startdate and @enddate and
      t3.ccs_category = 113 and
      t1.claimtype='u' and not exists
      (select 1
       from medicalclaim t1,
            diagnosis t2,
            ccs_category t3
      where t1.memberid=t1.memberid and
      t1.claimid=t2.claimid and
      t2.icd9code=t3.icd9code and
      t1.fromdate between @startdate and @enddate and
      t3.ccs_category = 113 and
      t1.claimtype='u')
from medicalclaim t2
where t2.memberid=@member and
t1.fromdate=t2.fromdate and
t2.claimtype='u' and
(t1.revcode between '00100' and '00160' or
t1.revcode between '00200' and '00214') )

insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'1',
'stroke',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 113 and
t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
t1.revcode between '00200' and '00214')

end

if (@109_flag = 'T' or @110_flag = 'T' or @111_flag = 'T' or
@112_flag = 'T' or @113_flag = 'T')
begin
select @strokeflag=1
end
else
begin
select @strokeflag=0
end

go
APPENDIX B.8 – STORED PROCEDURE NEPHROPATHY

use diabetes
go

-- Location: PhD\Structures\Stored Procedures
-- File: proc_renal.sql
-- Author: Kenn B. Daratha
-- Date: 2-24-2004
--
-- Purpose: Creates a stored procedure to input the parameters of memberid and the
diagnosis period date range and return the renal status of the
patient. A '0' indicates no and a '1' indicates yes for comorbidities.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_renal' AND type = 'P')
    DROP PROCEDURE proc_renal
go

CREATE PROCEDURE proc_renal
    @member int,
    @startdate datetime,
    @enddate datetime,
    @period char(6),
    @renalflag int output,
    @esrdflag int output
AS
-- Check for a medical claim for 50 - diabetic renal complications
declare @50_flag char(1)

select @50_flag =
    (select max('T')
    from medicalclaim t1,
        diagnosis t2,
        ccs_category t3
    where t1.memberid=@member and
        t1.claimid=t2.claimid and
        t2.icd9code=t3.icd9code and
        t1.fromdate between @startdate and @enddate and
        t3.ccs_category = 50 and
        t2.icd9code like '2504%' and
        (t1.claimtype='u' or
            (t1.claimtype='h' and
                t1.cptcode between '99201' and '99357' or
                t1.cptcode between '99421' and '99428' or
                t1.cptcode between '99504' and '99506' or
                t1.cptcode between '99563' and '99573' or
                t1.cptcode between '99585' and '99587'))
    )

begin
insert rulelog
select distinct
    t1.memberid,
    t3.ccs_category,
    t1.fromdate,
    'p',
    'renal',
    t4.rbrvs,
    @period
from medicalclaim t1,
    diagnosis t2,
    ccs_category t3,
    rbrvs t4
where t1.memberid=@member and
    t1.claimid=t2.claimid and
    t2.icd9code=t3.icd9code and
    t1.cptcode=t4.cptcode and
    t1.fromdate between @startdate and @enddate and
    t3.ccs_category = 50 and
    t2.icd9code like '2504%' and
    t1.claimtype='h' and
    (t1.cptcode between '99201' and '99357' or
    t1.cptcode between '99381' and '99429')
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where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and

t1.fromdate between @startdate and @enddate and
t3.ccs_category = 50 and
t2.icd9code like '2504%' and
t1.claimtype='u' and not exists
(select 1
from medicalclaim t2
where t2.memberid=@member and
t1.fromdate=t2.fromdate and

t2.claimtype='u' and
(t1.revcode between '00100' and '00160' or
 t1.revcode between '00200' and '00214') )

insert rulelog
select distinct
 t1.memberid,
 t3.ccs_category,
 t1.fromdate,
 'i',
 'renal',
 0,
 @period
from medicalclaim t1,
 diagnosis t2,
 ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and

t1.fromdate between @startdate and @enddate and
t3.ccs_category = 50 and
t2.icd9code like '2504%' and
t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
 t1.revcode between '00200' and '00214')

end

-- Check for a medical claim for other renal complications
declare @other_renal_flag char(1)
select @other_renal_flag =
  (select max('T')
   from    medicalclaim t1,
           diagnosis t2,
           ccs_category t3
   where t1.memberid=@member and
         t1.claimid=t2.claimid and
         t2.icd9code=t3.icd9code and
         t1.fromdate between @startdate and @enddate and
         t3.ccs_category in (114,115,213) and
         t2.icd9code in ('4401','4421','74762') and
         (t1.claimtype='u' or
          (t1.claimtype='h' and
           (t1.cptcode between '99201' and '99357' or
            t1.cptcode between '99381' and '99429' or
            t1.cptcode = '99499')))
  )

if (@other_renal_flag='T')
begin
  insert rulelog
  select distinct
         t1.memberid,
         t3.ccs_category,
         t1.fromdate,
         'p',
         'renal',
         t4.rbrvs,
         @period
  from    medicalclaim t1,
          diagnosis t2,
          ccs_category t3,
          rbrvs t4
  where t1.memberid=@member and
         t1.claimid=t2.claimid and
         t2.icd9code=t3.icd9code and
         t1.cptcode=t4.cptcode and
         t1.fromdate between @startdate and @enddate and
         t3.ccs_category in (114,115,213) and
         t2.icd9code in ('4401','4421','74762') and
         t1.claimtype='h' and
(t1.cptcode between '99201' and '99357' or
t1.cptcode between '99381' and '99429')

insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'o',
'renal',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
    t2.icd9code=t3.icd9code and
    t1.fromdate between @startdate and @enddate and
    t3.ccs_category in (114,115,213) and
    t2.icd9code in ('4401','4421','74762') and
    t1.claimtype='u' and not exists
    (select 1
    from    medicalclaim t2
    where    t2.memberid=@member and
    t1.fromdate=t2.fromdate and
    t2.claimtype='u' and
    (t1.revcode between '00100' and '00160' or
    t1.revcode between '00200' and '00214') )

insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'i',
'renal',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.from date between @startdate and @enddate and
t3.ccs_category in (114,115,213) and
t2.icd9code in ('4401','4421','74762') and
t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
 t1.revcode between '00200' and '00214')

end

-- Check for a medical claim for 158 - chronic renal failure
declare @158_flag  char(1)
select @158_flag =
 (select max('T')
     from medicalclaim t1,
         diagnosis t2,
         ccs_category t3
     where t1.memberid=@member and
           t1.claimid=t2.claimid and
           t2.icd9code=t3.icd9code and
           t1.from date between @startdate and @enddate and
           t3.ccs_category = 158 and
           (t1.claimtype='u' or
            (t1.claimtype='h' and
             (t1.cptcode between '99201' and '99357' or
              t1.cptcode between '99381' and '99429' or
              t1.cptcode = '99499'))
         )
     )
if @158_flag='T'
begin
    insert rulelog
    select distinct
       t1.memberid,
       t3.ccs_category,
       t1.from date,
       'p',
       'esrd',
       t4.rbrvs,
       @period
from medicalclaim t1,
diagnosis t2,
ccs_category t3,
rbrvs t4
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1cptcode=t4cptcode and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 158 and
t1.claimtype='h' and
(t1cptcode between '99201' and '99357' or
t1cptcode between '99381' and '99429')
insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'o',
'esrd',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 158 and
t1.claimtype='u' and not exists
(select 1
from medicalclaim t2
where t2.memberid=@member and
t1.fromdate=t2.fromdate and
(t2.claimtype='u' and
(t1.revcode between '00100' and '00160' or
 t1.revcode between '00200' and '00214')
insert rulelog
select distinct
196
t1.memberid,
  t3.ccs_category,
  t1.fromdate,
  'i',
  'esrd',
  0,
  @period
from medicalclaim t1,
    diagnosis t2,
    ccs_category t3
where t1.memberid=@member and
  t1.claimid=t2.claimid and
  t2.icd9code=t3.icd9code and
  t1.fromdate between @startdate and @enddate and
  t3.ccs_category = 158 and
  t1.claimtype='u' and
  (t1.revcode between '00100' and '00160' or
   t1.revcode between '00200' and '00214')
end

-- Check for a medical claim for other esrd complications
declare @other_esrd_flag  char(1)

select @other_esrd_flag =
  (select max('T')
   from medicalclaim t1,
       diagnosis t2,
       ccs_category t3
   where t1.memberid=@member and
     t1.claimid=t2.claimid and
     t2.icd9code=t3.icd9code and
     t1.fromdate between @startdate and @enddate and
     t3.ccs_category in (237) and
     t2.icd9code in ('99681','99673') and
     (t1.claimtype='u' or
      (t1.claimtype='h' and
       (t1.cptcode between '99201' and '99357' or
        t1.cptcode between '99381' and '99429' or
        t1.cptcode = '99499'))
    )
  )
)
if (@other_esrd_flag='T')
begin
    insert rulelog
    select distinct
        t1.memberid,
        t3.ccs_category,
        t1.fromdate,
        'p',
        'esrd',
        t4.rbrvs,
        @period
    from medicalclaim t1,
        diagnosis t2,
        ccs_category t3,
        rbrvs t4
    where t1.memberid=@member and
          t1.cla imid=t2.claimid and
          t2.icd9code=t3.icd9code and
          t1.cptcode=t4.cptcode and
          t1.from date between @startdate and @enddate and
          t3.ccs_category in (237) and
          t2.icd9code in ('99681','99673') and
          t1.claimtype='h' and
          (t1.cptcode between '99201' and '99357' or
           t1.cptcode between '99381' and '99429')

    insert rulelog
    select distinct
        t1.memberid,
        t3.ccs_category,
        t1.fromdate,
        'o',
        'esrd',
        0,
        @period
    from medicalclaim t1,
        diagnosis t2,
        ccs_category t3
    where t1.memberid=@member and
          t1.cla imid=t2.claimid and
          t2.icd9code=t3.icd9code and
          t1.from date between @startdate and @enddate and
          t3.ccs_category in (237) and
          t2.icd9code in ('99681','99673') and
          t1.claimtype='h' and
          (t1.cptcode between '99201' and '99357' or
           t1.cptcode between '99381' and '99429')
t2.icd9code in ('99681','99673') and

    t1.claimtype='u' and not exists
    (select 1
    from medicalclaim t2
    where t2.memberid=@member and
    t1.fromdate=t2.fromdate and

    t2.claimtype='u' and
       (t1.revcode between '00100' and '00160' or
        t1.revcode between '00200' and '00214') )

insert rulelog
select distinct
    t1.memberid,
    t3.ccs_category,
    t1.fromdate,
    'i',
    'esrd',
    0,
    @period
from medicalclaim t1,
     diagnosis t2,
     ccs_category t3
where t1.memberid=@member and
    t1.claimid=t2.claimid and
    t2.icd9code=t3.icd9code and

    t1.fromdate between @startdate and @enddate and
    t3.ccs_category in (237) and
    t2.icd9code in ('99681','99673') and
    t1.claimtype='u' and
    (t1.revcode between '00100' and '00160' or
     t1.revcode between '00200' and '00214')

end

if ( @50_flag = 'T' or @other_renal_flag = 'T')
begin
    select @renalflag=1
end
else
begin
    select @renalflag=0
end
if (@158_flag = 'T' or @other_esrd_flag = 'T')
    begin
        select @esrd_flag=1
    end
else
    begin
        select @esrd_flag=0
    end

go
APPENDIX B.9 – STORED PROCEDURE RETINOPATHY

use diabetes

go

-- Location: PhD\Structures\Stored Procedures
-- File: proc_retinal.sql
-- Author: Kenn B. Daratha
-- Date: 2-24-2004

-- Purpose: Creates a stored procedure to input the parameters of memberid and the
diagnosis period date range and return the retinal status of the
patient. A '0' indicates no and a '1' indicates yes for comorbidities.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_retinal' AND type = 'P')
    DROP PROCEDURE proc_retinal

CREATE PROCEDURE proc_retinal
    @member int,
    @startdate datetime,
    @enddate datetime,
    @period char(6),
    @retinaflag int output,
    @blindflag int output
AS

-- Check for a medical claim for 50 - diabetic retinal complications
declare @50_flag char(1)

select @50_flag =
    (select max('T')
        from medicalclaim t1,
            diagnosis t2,
            ccs_category t3
        where t1.memberid=@member and
            t1.claimid=t2.claimid and
            t2.icd9code=t3.icd9code and
            t1.fromdate between @startdate and @enddate and
            t2.icd9code like '2505%' and
            (t1.claimtype='u' or
             (t1.claimtype='h' and
                (t1.cptcode in ('67101','67105','67107','67108','67110',

    select @50_flag =
    (select max('T')
        from medicalclaim t1,
            diagnosis t2,
            ccs_category t3
        where t1.memberid=member and
            t1.claimid=t2.claimid and
            t2.icd9code=t3.icd9code and
            t1.fromdate between @startdate and @enddate and
            t3.ccs_category = 50 and
            t2.icd9code like '2505%' and
            (t1.claimtype='u' or
             (t1.claimtype='h' and
                (t1.cptcode in ('67101','67105','67107','67108','67110',

201
if @50_flag='T'
begin
    insert rulelog
select distinct
    t1.memberid,
    t3.ccs_category,
    t1.fromdate,
    'p',
    'retinal',
    t4.rbrvs,
    @period
from medicalclaim t1,
    diagnosis t2,
    ccs_category t3,
    rbrvs t4
where t1.memberid=@member and
    t1.claimid=t2.claimid and
    t2.icd9code=t3.icd9code and
    t1.cptcode=t4.cptcode and
    t1.fromdate between @startdate and @enddate and
    t3.ccs_category = 50 and
    t2.icd9code like '2505%' and
    t1.claimtype='h' and
    (t1.cptcode in ('67101','67105','67107','67108','67110',
    '67112','67141','67145','67208','67210',
    '67218','67227','67228','92002','92004',
    '92012','92018','92014','92019','92225',
    '92226','92230','92235','92240','92250',
    '92260','92287') or
    t1.cptcode between '99201' and '99357' or
    t1.cptcode between '99381' and '99429' or
    t1.cptcode = '99499')
)
)
insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'o',
'retinal',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 50 and
t2.icd9code like '2505%' and
t1.claimtype='u' and not exists
(select 1
from medicalclaim t2
where t2.memberid=@member and
t1.fromdate=t2.fromdate and
t2.claimtype='u' and
(t1.revcode between '00100' and '00160' or
t1.revcode between '00200' and '00214') )

insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'i',
'retinal',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and

    t1.fromdate between @startdate and @enddate and
    t3.ccs_category = 50 and
    t2.icd9code like '2505%' and
    t1.claimtype='u' and
    (t1.revcode between '00100' and '00160' or
    t1.revcode between '00200' and '00214')

end

-- Check for a medical claim for 87 - diabetic retinopathy
declare @87_flag char(1)

select @87_flag =
    (select max('T')
     from    medicalclaim t1,
             diagnosis t2,
             ccs_category t3
     where    t1.memberid=@member and
              t1.claimid=t2.claimid and
              t2.icd9code=t3.icd9code and
              t1.fromdate between @startdate and @enddate and
              t3.ccs_category = 87 and
              t2.icd9code like '362%' and
              (t1.claimtype='u' or
               (t1.claimtype='h' and
                (t1 cptcode in ('67101','67105','67107','67108','67110',
                 '67112','67114','67145','67208','67210',
                 '67218','67227','67228','92002','92004',
                 '92012','92018','92014','92019','92225',
                 '92226','92230','92235','92240','92250',
                 '92260','92287') or
                 t1.cptcode between '99201' and '99357' or
                 t1.cptcode between '99381' and '99429' or
                 t1.cptcode = '99499')
               ))
    )

if @87_flag='T'
begin
    insert rulelog
    select distinct
        t1.memberid,
t3.ccs_category,
t1.fromdate,
'p',
'retinal',
t4.rbrvs,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3,
rbrvs t4
where t1.memberid=@member and
   t1.claimid=t2.claimid and
   t2.icd9code=t3.icd9code and
   t1 cptcode=t4.cptcode and

   t1.fromdate between @startdate and @enddate and
   t3.ccs_category = 87 and
   t2.icd9code like '362%' and
   t1.claimtype='h' and
   (t1.cptcode in ('67101','67105','67107','67108','67110',
                  '67112','67114','67145','67208','67210',
                  '67218','67227','67228','92002','92004',
                  '92012','92018','92014','92019','92225',
                  '92226','92230','92235','92240','92250',
                  '92260','92287') or
   t1.cptcode between '99201' and '99357' or
   t1.cptcode between '99381' and '99429' or
   t1.cptcode = '99499')

insert rulelog
select distinct
   t1.memberid,
   t3.ccs_category,
   t1.fromdate,
   'o',
   'retinal',
   0,
   @period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
   t1.claimid=t2.claimid and
   t2.icd9code=t3.icd9code and

   t1.fromdate between @startdate and @enddate and
t3.ccs_category = 87 and
t2.icd9code like '362%' and
t1.claimtype='u' and not exists
(select 1
from medicalclaim t2
where t2.memberid=@member and
t1.fromdate=t2.fromdate and
t2.claimtype='u' and
(t1.revcode between '00100' and '00160' or
 t1.revcode between '00200' and '00214')
)

insert rulelog
select distinct
 t1.memberid,
 t3.ccs_category,
 t1.fromdate,
 'i',
 'retinal',
 0,
 @period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 87 and
t2.icd9code like '362%' and
t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
 t1.revcode between '00200' and '00214')
end

-- Check for a medical claim for 89 - blindness
declare @89_flag char(1)

select @89_flag =
 (select max('T')
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where  
  t1.memberid=@member and  
  t1.claimid=t2.claimid and  
  t2.icd9code=t3.icd9code and  
  
  t1.fromdate between @startdate and @enddate and  
  t3.ccs_category = 89 and  
  t2.icd9code like '369%' and  
  (t1.claimtype='u' or  
   (t1.claimtype='h' and  
    (t1.cptcode in ('67101','67105','67107','67108','67110',  
     '67112','67114','67145','67208','67210',  
     '67218','67227','67228','92002','92004',  
     '92012','92018','92014','92019','92225',  
     '92226','92229','92235','92240','92250',  
     '92260','92287') or  
    t1.cptcode between '99201' and '99357' or  
    t1.cptcode between '99381' and '99429' or  
    t1.cptcode = '99499'))
  
if @89_flag='T'  
begin
  insert rulelog  
  select distinct  
    t1.memberid,  
    t3.ccs_category,  
    t1.fromdate,  
    'p',  
    'blind',  
    t4.rbrvs,  
    @period  
  from medicalclaim t1,  
     diagnosis t2,  
     ccs_category t3,  
     rbrvs t4  
  where  
    t1.memberid=@member and  
    t1.claimid=t2.claimid and  
    t2.icd9code=t3.icd9code and  
    t1.cptcode=t4.cptcode and  
    
    t1.fromdate between @startdate and @enddate and  
    t3.ccs_category = 89 and  
    t2.icd9code like '369%' and  
    t1.claimtype='h' and
(t1.cptcode in ('67101','67105','67107','67108','67110',  
'67112','67141','67145','67208','67210',  
'67218','67227','67228','92002','92004',  
'92012','92018','92014','92019','92225',  
'92226','92230','92235','92240','92250',  
'92260','92287') or  
 t1.cptcode between '67930' and '67935' or  
 t1.cptcode between '99381' and '99429' or  
 t1.cptcode = '99499')

insert rulelog
select distinct  
t1.memberid,  
t3.ccs_category,  
t1.fromdate,  
'o',  
'blind',  
0,  
@period  
from medicalclaim t1,  
diagnosis t2,  
ccs_category t3  
where t1.memberid=@member and  
t1.claimid=t2.claimid and  
t2.icd9code=t3.icd9code and  

  t1.fromdate between @startdate and @enddate and  
t3.ccs_category = 89 and  
t2.icd9code like '369%' and  

  t1.claimtype='u' and not exists  
  (select 1  
   from medicalclaim t2  
   where t2.memberid=@member and  
   t1.fromdate=t2.fromdate and  
   t2.claimtype='u' and  
   (t1.revcode between '00100' and '00160' or  
   t1.revcode between '00200' and '00214')  
  )

insert rulelog
select distinct  
t1.memberid,  
t3.ccs_category,  
t1.fromdate,  
'i',  
0,  
@period  
from medicalclaim t1,  
diagnosis t2,  
ccs_category t3  
where t1.memberid=@member and  
t1.claimid=t2.claimid and  
t2.icd9code=t3.icd9code and  

  t1.fromdate between @startdate and @enddate and  
t3.ccs_category = 89 and  
t2.icd9code like '369%' and  

  t1.claimtype='u' and not exists  
  (select 1  
   from medicalclaim t2  
   where t2.memberid=@member and  
   t1.fromdate=t2.fromdate and  

   t2.claimtype='u' and  
   (t1.revcode between '00100' and '00160' or  
   t1.revcode between '00200' and '00214')))
'blind',
0,
@period
from medicalclaim t1,
   diagnosis t2,
   ccs_category t3,
   rbrvs t4
where t1.memberid=@member and
   t1.claimid=t2.claimid and
   t2.icd9code=t3.icd9code and
   t1.cptcode=t4.cptcode and
   t1.fromdate between @startdate and @enddate and
   t3.ccs_category = 89 and
   t2.icd9code in ('36900','36910','36960','3694') and
   t1.claimtype='u' and
   (t1.revcode between '00100' and '00160' or
    t1.revcode between '00200' and '00214')
end

if (@50_flag = 'T' or @87_flag = 'T')
begin
   select @retinalflag=1
end
else
begin
   select @retinalflag=0
end

if @89_flag = 'T'
begin
   select @blindflag=1
end
else
begin
   select @blindflag=0
end

go
APPENDIX B.10 – STORED PROCEDURE NEUROPATHY

use diabetes
go

-- Location: PhD\Structures\Stored Procedures
-- File: proc_neuro.sql
-- Author: Kenn B. Daratha
-- Date: 2-24-2004
--
-- Purpose: Creates a stored procedure to input the parameters of memberid and the
diagnosis period date range and return the neuro status of the
patient. A '0' indicates no and a '1' indicates yes for comorbidities.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_neuro' AND type = 'P')
    DROP PROCEDURE proc_neuro
go

CREATE PROCEDURE proc_neuro
    @member int,
    @startdate datetime,
    @enddate datetime,
    @period char(6),
    @neuroflag int output,
    @amputflag int output
AS
    -- Check for a medical claim for 50 - diabetic neuro complications
    declare @50_flag char(1)
    select @50_flag =
        (select max('T')
            from medicalclaim t1,
                diagnosis t2,
                ccs_category t3
            where t1.memberid=@member and
                t1.claimid=t2.claimid and
                t2.icd9code=t3.icd9code and
                t1.fromdate between @startdate and @enddate and
                t1.cptcode between '99201' and '99357'
            )
if (@50_flag='T')
begin
    insert rulelog
    select distinct
        t1.memberid,
        t3.ccs_category,
        t1.fromdate,
        'p',
        'neuro',
        t4.rbrvs,
        @period
    from medicalclaim t1,
        diagnosis t2,
        ccs_category t3,
        rbrvs t4
    where t1.memberid=@member and
        t1.claimid=t2.claimid and
        t2.icd9code=t3.icd9code and
        t1.cptcode=t4.cptcode and
        t1.fromdate between @startdate and @enddate and
        t3.ccs_category = 50 and
        t2.icd9code like '250[6-7]%' and
        t1.claimtype='h' and
        (t1.cptcode between '99201' and '99357' or
        t1.cptcode between '99381' and '99429')
end
end
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 50 and
t2.icd9code like '250[6-7]%' and
t1.claimtype='u' and not exists
(select 1
from    medicalclaim t2
where    t2.memberid=@member and
t1.fromdate=t2.fromdate and
(t1.revcode between '00100' and '00160' or
 t1.revcode between '00200' and '00214')
insert rulelog
select distinct
 t1.memberid,
 t3.ccs_category,
 t1.fromdate,
'1',
'neuro',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 50 and
t2.icd9code like '250[6-7]%' and
t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
 t1.revcode between '00200' and '00214')
end

-- Check for a medical claim for 197 - skin and subcutaneous tissue infections
declare @197_flag char(1)

select @197_flag =
  (select max('T')
   from medicalclaim t1,
        diagnosis t2,
        ccs_category t3
   where t1.memberid=@member and
     t1.claimid=t2.claimid and
     t2.icd9code=t3.icd9code and
     t1.fromdate between @startdate and @enddate and
     t3.ccs_category = 197 and
     t2.icd9code in ('6806','6807','6811','68110','68111','6826','6827') and
     (t1.claimtype='u' or
      (t1.claimtype='h' and
       (t1.cptcode between '99201' and '99357' or
        t1.cptcode between '99381' and '99429' or
        t1.cptcode = '99499')))
   )

if @197_flag='T'
begin
  insert rulelog
  select distinct t1.memberid,
    t3.ccs_category,
    t1.fromdate,
    'p',
    'neuro',
    t4.rbrvs,
    @period
  from medicalclaim t1,
       diagnosis t2,
       ccs_category t3,
       rbrvs t4
  where t1.memberid=@member and
    t1.claimid=t2.claimid and
    t2.icd9code=t3.icd9code and
    t1.cptcode=t4.cptcode and
    t1.fromdate between @startdate and @enddate and
t3.ccs_category = 197 and
t2.icd9code in ('6806','6807','6811','68110',
    '68111','6826','6827') and
t1.claimtype='h' and
(t1cptcode between '99201' and '99357' or
t1cptcode between '99381' and '99429')

insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'o',
'neuro',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and

select 1
from medicalclaim t2
where t2.memberid=@member and
t1.fromdate=t2.fromdate and

t2.claimtype='u' and not exists
(t1revcode between '00100' and '00160' or
 t1revcode between '00200' and '00214')
)

insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'i',
'neuro',
0,
DECLARE @period
FROM medicalclaim t1,
diagnosis t2,
ccs_category t3
WHERE t1.memberid = @member AND
    t1.claimid = t2.claimid AND
    t2.icd9code = t3.icd9code AND
    t1.fromdate BETWEEN @startdate AND @enddate AND
    t3.ccs_category = 197 AND
    t2.icd9code IN ('6806','6807','6811','68110','68111','6826','6827') AND
    t1.claimtype = 'u' AND
    (t1.revcode BETWEEN '00100' AND '00160' OR
     t1.revcode BETWEEN '00200' AND '00214')
END

-- Check for a medical claim for 199 - chronic ulcer of skin
DECLARE @199_flag CHAR(1)
SELECT @199_flag =
    (SELECT MAX('T')
     FROM medicalclaim t1,
         diagnosis t2,
         ccs_category t3
     WHERE t1.memberid = @member AND
         t1.claimid = t2.claimid AND
         t2.icd9code = t3.icd9code AND
         t1.fromdate BETWEEN @startdate AND @enddate AND
         t3.ccs_category = 199 AND
         t2.icd9code LIKE '7071%' AND
         (t1.claimtype = 'u' OR
          (t1.claimtype = 'h' AND
           (t1.cptcode BETWEEN '99201' AND '99357' OR
            t1.cptcode BETWEEN '99381' AND '99429' OR
            t1.cptcode = '99499'))
         )
    )
IF @199_flag = 'T'
BEGIN
    INSERT RULELOG
    -- Other logic...
END

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select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'p',
'neuro',
t4.rbrvs,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3,
rbrvs t4
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1cptcode=t4.cptcode and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 199 and
t2.icd9code like '7071%' and
t1.claimtype='h' and
(t1.cptcode between '99201' and '99357' or
t1.cptcode between '99381' and '99429')

insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'o',
'neuro',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 199 and
t2.icd9code like '7071%' and
t1.claimtype='u' and not exists
(select 1
  from medicalclaim t2
  where t2.memberid=@member and
    t1.fromdate=t2.fromdate and
    t2.claimtype='u' and
    (t1.revcode between '00100' and '00160' or
     t1.revcode between '00200' and '00214')
)

insert rulelog
select distinct
  t1.memberid,
  t3.ccs_category,
  t1.fromdate,
  'i',
  'neuro',
  0,
  @period
from medicalclaim t1,
  diagnosis t2,
  ccs_category t3
where t1.memberid=@member and
  t1.claimid=t2.claimid and
  t2.icd9code=t3.icd9code and
  t1.fromdate between @startdate and @enddate and
  t3.ccs_category = 199 and
  t2.icd9code like '7071%' and
  t1.claimtype='u' and
  (t1.revcode between '00100' and '00160' or
   t1.revcode between '00200' and '00214')
  
end

-- Check for a medical claim for 211 - other connective (lea)
declare @211_flag char(1)

select @211_flag =
  (select max('T')
    from medicalclaim t1,
      diagnosis t2,
      ccs_category t3
    where t1.memberid=@member and
      t1.claimid=t2.claimid and
      t2.icd9code=t3.icd9code and
      t2.icd9code like '7071%' and
      t1.claimtype='u' and
      t1.revcode between '00100' and '00160' or
      t1.revcode between '00200' and '00214')
t1.from date between @startdate and @enddate and

t3.ccs_category = 211 and
t2.icd9code like 'v497%' and
(t1.claimtype='u' or
    (t1.claimtype='h' and
        (t1.cptcode between '99201' and '99357' or
            t1.cptcode between '99381' and '99429' or
            t1.cptcode = '99499'))
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)
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
  t1.claimid=t2.claimid and
  t2.icd9code=t3.icd9code and
  t1.fromdate between @startdate and @enddate and
  t3.ccs_category = 211 and
  t2.icd9code like 'v497%' and
  t1.claimtype='u' and not exists
  (select 1
   from medicalclaim t2
   where t2.memberid=@member and
     t1.fromdate=t2.fromdate and
     t2.claimtype='u' and
     (t1.revcode between '00100' and '00160' or
      t1.revcode between '00200' and '00214'))

insert rulelog
select distinct
  t1.memberid,
  t3.ccs_category,
  t1.fromdate,
  'i',
  'amputation',
  0,
  @period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
  t1.claimid=t2.claimid and
  t2.icd9code=t3.icd9code and
  t1.fromdate between @startdate and @enddate and
  t3.ccs_category = 211 and
  t2.icd9code like 'v497%' and
  t1.claimtype='u' and
  (t1.revcode between '00100' and '00160' or
   t1.revcode between '00200' and '00214'))
-- Check for a medical claim for 248 - gangrene
declare @248_flag char(1)

select @248_flag =
(SELECT max('T')
FROM medicalclaim t1,
     diagnosis t2,
     ccs_category t3
WHERE t1.memberid=@member and 
     t1.claimid=t2.claimid and
     t2.icd9code=t3.icd9code and
     t1.fromdate between @startdate and @enddate and
     t3.ccs_category = 248 and
     (t1.claimtype='u' or
     (t1.claimtype='h' and
      (t1.cptcode between '99201' and '99357' or
       t1.cptcode between '99381' and '99429' or
       t1.cptcode = '99499'))
    )
    )

if @248_flag='T'
begin
    insert rulelog
    select distinct 
    t1.memberid,
    t3.ccs_category,
    t1.fromdate,
    'p',
    'neuro',
    t4.rbrvs,
    @period
    FROM medicalclaim t1,
         diagnosis t2,
         ccs_category t3,
         rbrvs t4
WHERE t1.memberid=@member and
      t1.claimid=t2.claimid and
      t2.icd9code=t3.icd9code and
      t1.cptcode=t4.cptcode and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 248 and
t1.claimtype='h' and
(t1cptcode between '99201' and '99357' or
t1.cptcode between '99381' and '99429')

insert rulelog
select distinct
  t1.memberid,
  t3.ccs_category,
  t1.fromdate,
  'o',
  'neuro',
  0,
  @period
from medicalclaim t1,
    diagnosis t2,
    ccs_category t3,
    rbrvs t4
where t1.memberid=@member and
  t1.claimid=t2.claimid and
  t2.icd9code=t3.icd9code and
  t1.cptcode=t4.cptcode and
  t1.fromdate between @startdate and @enddate and
  t3.ccs_category = 248 and
  t1.claimtype='u' and not exists
    (select 1
      from medicalclaim t2
      where t2.memberid=@member and
        t1.fromdate=t2.fromdate and
        t2.claimtype='u' and
        (t1.revcode between '00100' and '00160' or
         t1.revcode between '00200' and '00214'))

insert rulelog
select distinct
  t1.memberid,
  t3.ccs_category,
  t1.fromdate,
  'i',
  'neuro',
  0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.fromdate between @startdate and @enddate and
t3.ccs_category = 248 and
t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
t1.revcode between '00200' and '00214')
end

if ( @50_flag = 'T' or @197_flag = 'T' or @199_flag = 'T' or
@248_flag = 'T')
begin
    select @neuroflag=1
end
else
begin
    select @neuroflag=0
end

if @211_flag = 'T'
begin
    select @amputflag=1
end
else
begin
    select @amputflag=0
end

go
use diabetes
go

-- Location: PhD\Analysis
-- File: Update analysis_factors.sql
-- Date: 2/26/2004
-- Author: Kenn Daratha
-- Purpose: Sum rbrvs values in the rulelog table and update analysis_factors.
--
-- Last Run: 3/30/2004
-- Time: 7 Minutes 20 Seconds

declare @memberid int

declare analysis_cursor CURSOR FOR

select t1.memberid
from segmentation t1
where t1.studyflag in ('BaseStudy', 'BaseNoDrug')
order by 1

open analysis_cursor
fetch next from analysis_cursor
into @memberid

while @@fetch_status=0
begin

declare @cvd_rbrvs numeric(5,2)
select @cvd_rbrvs = (select sum(t1.rbrvs)
from rulelog t1
where t1.memberid=@memberid and
  t1.period='base' and
  t1.compflag in ('cvd',
                 'stroke',
                 'hypertension',
                 'dyslipidemia')
)

if @cvd_rbrvs is null
begin
  select @cvd_rbrvs = 0
end
declare @ren_rbrvs numeric(5,2)
select @ren_rbrvs = (select sum(t1.rbrvs)
    from rulelog t1
    where t1.memberid=@memberid and
        t1.period='base' and
        t1.compflag in ('esrd',
                       'renal')
)

if @ren_rbrvs is null
    begin
        select @ren_rbrvs = 0
    end

declare @ret_rbrvs numeric(5,2)
select @ret_rbrvs = (select sum(t1.rbrvs)
    from rulelog t1
    where t1.memberid=@memberid and
        t1.period='base' and
        t1.compflag in ('blind',
                       'retinal')
)

if @ret_rbrvs is null
    begin
        select @ret_rbrvs = 0
    end

declare @neu_rbrvs numeric(5,2)
select @neu_rbrvs = (select sum(t1.rbrvs)
    from rulelog t1
    where t1.memberid=@memberid and
        t1.period='base' and
        t1.compflag in ('amputation',
                       'neuro')
)

if @neu_rbrvs is null
    begin
        select @neu_rbrvs = 0
    end

declare @chrbrvs numeric(5,2)
select @chrbrvs = (@cvd_rbrvs + @ren_rbrvs + @ret_rbrvs + @neu_rbrvs)
update analysis_factors
set chrbrvs=@chrbrvs
where memberid=@memberid

-- Get the next patient to process
fetch next from analysis_cursor into @memberid
end

close analysis_cursor
deallocate analysis_cursor
go
use diabetes
go

-- Location: \PhD\Analysis\
-- File: Create analysis_tests Table.sql
-- Author: Kenn B. Daratha
-- Date: 2-26-2004
--
-- Purpose: Creates a table based on patient id with
-- variables used in this doctoral research.
--
-- Run Time: 22 Minutes 10 Seconds
-- Last Run: 3/30/2004

insert processcontrol values ('tests',null, null)
go

update processcontrol
set starttime=(select getdate())
where task='tests'
go

-- If the table already exists drop it.
if exists
    (select table_name
     from information_schema.tables
     where table_name='analysis_tests')
    drop table analysis_tests
go

-- Create the table analysis_tests
create table analysis_tests
    ( memberid int primary key,
      visits int,
      eyeexams int,
      a1ctests int,
      lipidtests int,
      albumintests int,
      totbrvs numeric(5,2)
    )
go

-- Grant privileges to analysis_tests to public.
grant select on analysis_tests to public
go

-- Initially populate the analysis table with default values.
insert analysis_tests
select distinct
t1.memberid,
-1,
-1,
-1,
-1,
-1,
-1
from segmentation t1
where t1.studyflag in ('BaseStudy','BaseNoDrug')
go

declare @memberid int
declare @firstdt datetime
declare @enddt datetime

declare analysis_cursor CURSOR
FOR

select distinct
t1.memberid,
t2.firstdate,
dateadd(dd,364,t2.firstdate)
from segmentation t1,
patient t2
where t1.memberid=t2.memberid and
    t1.studyflag in ('BaseStudy','BaseNoDrug')
order by 1

open analysis_cursor
fetch next from analysis_cursor
into @memberid, @firstdt, @enddt

while @@fetch_status=0
begin
    -- Determine the number of professional office visits for this patient in the base year
    declare @vis int
    exec proc_visits @memberid, @firstdt, @enddt, @visits=@vis output
    update analysis_tests
    set visits=@vis
    where memberid=@memberid
-- Determine the number of eye exams for this patient in the base year
declare @eye int
exec proc_eyeexams @memberid, @firstdt, @enddt, @eyeexams=@eye output
update analysis_tests
set eyeexams=@eye
where memberid=@memberid

-- Determine the number of A1C tests for this patient in the base year
declare @a1c int
exec proc_a1ctests @memberid, @firstdt, @enddt, @a1ctests=@a1c output
update analysis_tests
set a1ctests=@a1c
where memberid=@memberid

-- Determine the number of lipids tests for this patient in the base year
declare @lip int
exec proc_lipidstests @memberid, @firstdt, @enddt, @lipidstests=@lip output
update analysis_tests
set lipidstests=@lip
where memberid=@memberid

-- Determine the number of albumin tests for this patient in the base year
declare @alb int
exec proc_albumintests @memberid, @firstdt, @enddt, @albumintests=@alb output
update analysis_tests
set albumintests=@alb
where memberid=@memberid

-- Determine the total professional rbrvs for this patient in the base year
declare @rbr numeric(5,2)
exec proc_rbrvs @memberid, @firstdt, @enddt, @rbrvs=@rbr output
update analysis_tests
set totrbrvs=@rbr
where memberid=@memberid

-- Get the next patient to process
fetch next from analysis_cursor into @memberid, @firstdt, @enddt
end

close analysis_cursor
deallocate analysis_cursor
go

update processcontrol
set endtime=(select getdate())
where task='tests'
go
APPENDIX B.13 – STORED PROCEDURE VISITS

Use diabetes
go

-- Location: PhD\Structures\Stored Procedures
-- File: proc_visits.sql
-- Author: Kenn B. Daratha
-- Date: 2-26-2004
--
-- Purpose: Creates a stored procedure to input the parameters of memberid and the
date range and return the number of professional visits this patient had
within this patient's base year of this study.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_visits' AND type = 'P')
  DROP PROCEDURE proc_visits
go

CREATE PROCEDURE proc_visits
  @member int,
  @firstdt datetime,
  @enddt datetime,
  @visits int output
AS

-- Check medical claims for number of professional visits
select @visits =
  (select count(distinct(t1.fromdate))
  from medicalclaim t1
  where t1.memberid = @member and
        t1.fromdate between @firstdt and @enddt and
        t1.claimtype = 'h' and
        (t1cptcode between '99201' and '99357' or
        t1 cptcode between '99381' and '99429' or
        t1.cptcode = '99499')

  )

go
use diabetes

-- Location: PhD\Structures\Stored Procedures
-- File: proc_rbrvs.sql
-- Author: Kenn B. Daratha
-- Date: 2-26-2004
--
-- Purpose: Creates a stored procedure to input the parameters of memberid and the
date range and return the total number of professional rbrvs this patient
had within the patient's base year of this study.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_rbrvs' AND type = 'P')
    DROP PROCEDURE proc_rbrvs

CREATE PROCEDURE proc_rbrvs
    @member int,
    @firstdt datetime,
    @enddt datetime,
    @rbrvs numeric(5,2) output
AS

-- Check medical claims for number of professional rbrvs
select @rbrvs =
    (select convert(numeric(5,2),sum(t2.rbrvs))
        from medicalclaim t1,
             rbrvs t2
        where t1.cptcode=t2.cptcode and
            t1.memberid=@member and
            t1.fromdate between @firstdt and @enddt and
            t1.claimtype='h' and
            (t1.cptcode between '99201' and '99357' or
             t1.cptcode between '99381' and '99429' or
             t1.cptcode = '99499')
    )

if @rbrvs is null
    begin
        select @rbrvs=0
    end

go
APPENDIX B.15 – STORED PROCEDURE DEPRESSION

use diabetes

go

-- Location: PhD\Structures\Stored Procedures
-- File: proc_depression.sql
-- Author: Kenn B. Daratha
-- Date: 2-24-2004
--
-- Purpose: Creates a stored procedure to input the parameters of memberid and the
diagnosis period date range and return the depression status of the
patient. A '0' indicates no and a '1' indicates yes for comorbidities.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_depression' AND type = 'P')
    DROP PROCEDURE proc_depression

go

CREATE PROCEDURE proc_depression
    @member       int,
    @startdate    datetime,
    @enddate      datetime,
    @period       char(6),
    @depressflag  int output
AS
    -- Check for a medical claim for 69 - depression affective disorders
    declare @69_flag char(1)

    select @69_flag =
        (select max('T')
            from medicalclaim t1,
                diagnosis t2,
                ccs_category t3
            where t1.memberid=@member and
                t1.claimid=t2.claimid and
                t2.icd9code=t3.icd9code and
                t1.fromdate between @startdate and @enddate and
                t3.ccs_category =69 and
                (t2.icd9code like '269[2-3]%' or
                    t2.icd9code in ('2980','3004')) and
                (t1.claimtype='u' or
                    (t1.claimtype='h' and
                        (t1.cptcode between '90801' and '90876' or
                        @69_flag = 'T')
                    )
            )
        )

        
        if exists (select name from sysobjects
            where name = 'proc_depression' and type = 'P'
        )
            drop procedure proc_depression

        go

CREATE PROCEDURE proc_depression
    @member       int,
    @startdate    datetime,
    @enddate      datetime,
    @period       char(6),
    @depressflag  int output
AS
    -- Check for a medical claim for 69 - depression affective disorders
    declare @69_flag char(1)

    select @69_flag =
        (select max('T')
            from medicalclaim t1,
                diagnosis t2,
                ccs_category t3
            where t1.memberid=@member and
                t1.claimid=t2.claimid and
                t2.icd9code=t3.icd9code and
                t1.fromdate between @startdate and @enddate and
                t3.ccs_category =69 and
                (t2.icd9code like '269[2-3]%' or
                    t2.icd9code in ('2980','3004')) and
                (t1.claimtype='u' or
                    (t1.claimtype='h' and
                        (t1.cptcode between '90801' and '90876' or
                        @69_flag = 'T')
                    )
            )
        )
if (@69_flag='T') begin
insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'p',
'depression',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
    t1.claimid=t2.claimid and
    t2.icd9code=t3.icd9code and
    t1.fromdate between @startdate and @enddate and
    t3.ccs_category = 69 and
    (t2.icd9code like '269[2-3]%' or
     t2.icd9code in ('2980','3004')) and
    t2.flag='p' and
    t1.claimtype='h' and
    (t1cptcode between '90801' and '90876' or
    t1cptcode between '99201' and '99357' or
    t1cptcode between '99381' and '99429')
end
insert rulelog
select distinct
t1.memberid,
t3.ccs_category,
t1.fromdate,
'o',
'depression',
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
  t1.claimid=t2.claimid and
  t2.icd9code=t3.icd9code and
  t1.fromdate between @startdate and @enddate and
  t3.ccs_category = 69 and
  (t2.icd9code like '269[2-3]%' or
   t2.icd9code in ('2980','3004')) and
  t2.flag='p' and
  t1.claimtype='u' and not exists
  (select 1
   from medicalclaim t2
   where t2.memberid=@member and
     t1.fromdate=t2.fromdate and
     t2.claimtype='u' and
     (t1.revcode between '00100' and '00160' or
      t1.revcode between '00200' and '00214')
   )

insert rulelog
select distinct
  t1.memberid,
  t3.ccs_category,
  t1.fromdate,
  'i',
  'depression',
  0,
  @period
from medicalclaim t1,
  diagnosis t2,
  ccs_category t3
where t1.memberid=@member and
  t1.claimid=t2.claimid and
  t2.icd9code=t3.icd9code and
  t1.fromdate between @startdate and @enddate and
  t3.ccs_category = 69 and
  (t2.icd9code like '269[2-3]%' or
   t2.icd9code in ('2980','3004')) and
  t2.flag='p' and
  t1.claimtype='u' and
  (t1.revcode between '00100' and '00160' or
   t1.revcode between '00200' and '00214')
-- Check for a medical claim for 74 - other mental conditions
declare @74_flag char(1)

select @74_flag =
    (select max('T')
     from medicalclaim t1,
             diagnosis t2,
             ccs_category t3
     where t1.memberid=@member and
          t1.claimid=t2.claimid and
          t2.icd9code=t3.icd9code and
          t1.fromdate between @startdate and @enddate and
          t3.ccs_category = 74 and
          t2.icd9code in ('3091','311') and
          (t1.claimtype='u' or
           (t1.claimtype='h' and
            (t1.cptcode between '90801' and '90876' or
             t1.cptcode between '99201' and '99357' or
             t1.cptcode between '99381' and '99429' or
             t1.cptcode = '99499'))
          )
     )

if @74_flag='T'
begin
    insert rulelog
    select distinct
        t1.memberid,
        t3.ccs_category,
        t1.fromdate,
        'p',
        'depression',
        0,
        @period
    from medicalclaim t1,
         diagnosis t2,
         ccs_category t3
    where t1.memberid=@member and
          t1.claimid=t2.claimid and
          t2.icd9code=t3.icd9code and
          t1.fromdate between @startdate and @enddate and
t3.ccs_category = 74 and
t2.icd9code in ('3091', '311') and
t2.flag = 'p' and
t1.claimtype = 'h' and
(t1cptcode between '90801' and '90876' or
t1.cptcode between '99201' and '99357' or
t1.cptcode between '99381' and '99429')

insert rulelog
select distinct
  t1.memberid,
  t3.ccs_category,
  t1.fromdate,
  'o',
  'depression',
  0,
  @period
from medicalclaim t1,
  diagnosis t2,
  ccs_category t3
where t1.memberid = @member and
  t1.claimid = t2.claimid and
  t2.icd9code = t3.icd9code and
  t1.fromdate between @startdate and @enddate and
  t3.ccs_category = 74 and
  t2.icd9code in ('3091', '311') and
  t2.flag = 'p' and
  t1.claimtype = 'u' and not exists
  (select 1
   from medicalclaim t2
   where t2.memberid = @member and
     t1.fromdate = t2.fromdate and
     t2.claimtype = 'u' and
     (t1.revcode between '00100' and '00160' or
      t1.revcode between '00200' and '00214'))

insert rulelog
select distinct
  t1.memberid,
  t3.ccs_category,
  t1.fromdate,
  'i',
  'depression',
  0,
  @period
from medicalclaim t1,
0,
@period
from medicalclaim t1,
diagnosis t2,
ccs_category t3
where t1.memberid=@member and
t1.claimid=t2.claimid and
t2.icd9code=t3.icd9code and
t1.from_date between @startdate and @enddate and
t2.icd9code in ('3091','311') and
t2.flag='p' and
t1.claim_type='u' and
(t1.revcode between '00100' and '00160' or
 t1.revcode between '00200' and '00214')
end

if (@69_flag = 'T' or @74_flag = 'T')
    begin
        select @depressflag=1
    end
else
    begin
        select @depressflag=0
    end

go
APPENDIX B.16 – STORED PROCEDURE EYE EXAMS

use diabetes

go

-- Location:  PhD\Structures\Stored Procedures
-- File:  proc_eyeexams.sql
-- Author:  Kenn B. Daratha
-- Date:  2-26-2004
--
-- Purpose:  Creates a stored procedure to input the parameters of memberid and the
date range and return an indicator of professional eye exams this patient had
within the patient's base year of this study.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_eyeexams' AND type = 'P')
    DROP PROCEDURE proc_eyeexams
    go

CREATE PROCEDURE proc_eyeexams
    @member  int,
    @firstdt  datetime,
    @enddt   datetime,
    @eyeexams int output
AS

    -- Check medical claims for number of professional eye exams
    select @eyeexams =
        (select max(1)
         from  medicalclaim t1
         where  t1.memberid=@member and
         t1.fromdate between @firstdt and @enddt and
         t1.cptcode in (67101,67105,67107,67108,67110,
         '67112','67141','67208','67210',
         '67218','67227','67228','92002','92004',
         '92012','92018','92019','92225',
         '92226','92230','92260','92262',
         '92250'))

    if @eyeexams is null
        begin
            select @eyeexams=0
        end

    go
use diabetes

go

-- Location: PhD\Structures\Stored Procedures
-- File: proc_a1c.sql
-- Author: Kenn B. Daratha
-- Date: 2-26-2004
--
-- Purpose: Creates a stored procedure to input the parameters of memberid and the
date range and return the indicator of A1C exams this patient had
within the patient's base year of this study.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_a1ctests' AND type = 'P')
    DROP PROCEDURE proc_a1ctests
go

CREATE PROCEDURE proc_a1ctests
    @member int,
    @firstdt datetime,
    @enddt datetime,
    @a1ctests int output
AS

-- Check medical claims for number of professional a1c
select @a1ctests =
    (select max(1)
    from medicalclaim t1
    where t1.memberid=@member and
        t1.fromdate between @firstdt and @enddt and
        t1.cptcode in ('83036') )

if @a1ctests is null
    begin
        select @a1ctests=0
    end

go
APPENDIX B.18 – STORED PROCEDURE LIPID TESTING

use diabetes

go

-- Location:  PhD\Structures\Stored Procedures
-- File:  proc_lipids.sql
-- Author:  Kenn B. Daratha
-- Date:  2-26-2004
--
-- Purpose:  Creates a stored procedure to input the parameters of memberid and the
date range and return the indicator of lipids exams this patient had
within the patient's base year of the study.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_lipidstests' AND type = 'P')
    DROP PROCEDURE proc_lipidstests
    go

CREATE PROCEDURE proc_lipidstests
    @member int,
    @firstdt datetime,
    @enddt datetime,
    @lipidstests int output
    AS

    -- Check medical claims for number of professional lipids
    select @lipidstests =
        (select max(1)
            from medicalclaim t1
            where t1.memberid=@member and
            t1.fromdate between @firstdt and @enddt and
            t1.cptcode in ('80061','83715','83716','83721') )

    if @lipidstests is null
        begin
            select @lipidstests=0
        end

    go
APPENDIX B.19 – STORED PROCEDURE ALBUMIN TESTING

use diabetes

go

-- Location: PhD\Structures\Stored Procedures
-- File: proc_albumin.sql
-- Author: Kenn B. Daratha
-- Date: 2-26-2004
--
-- Purpose: Creates a stored procedure to input the parameters of memberid and the
date range and return the indicator of albumin tests this patient had
within the patient's base year of the study.

IF EXISTS (SELECT name FROM sysobjects
WHERE name = 'proc_albumintests' AND type = 'P')
DROP PROCEDURE proc_albumintests

GO

CREATE PROCEDURE proc_albumintests
@member int,
@firstdt datetime,
@enddt datetime,
@albumintests int output
AS

-- Check medical claims for number of professional albumin
select @albumintests =
(select max(1)
from medicalclaim t1
where t1.memberid=@member and
  t1.fromdate between @firstdt and @enddt and
  (t1.cptcode in ('82042','82043','82044','84155','84160') or
   t1.cptcode = '84165' and exists
    ( select 1
      from medicalclaim t2
      where t1.memberid=t2.memberid and
        t1.fromdate=t2.fromdate and
        t2.cptcode='81050') ) )

if @albumintests is null
begin
  select @albumintests=0
end

GO
use diabetes

go

-- Location: \PhD\Analysis
-- File: Create analysis_outcomes Table.sql
-- Author: Kenn B. Daratha
-- Date: 2-26-2004
--
-- Purpose: Creates a table based on patient id with
-- variables used in this doctoral research.
--
-- Run Time: 28 Minutes 16 Seconds
-- Last Run: 3/30/2004

delete
from processcontrol
where task='outcomes'
go

insert processcontrol values ('outcomes',null, null)
go

update processcontrol
set starttime=(select getdate())
where task='outcomes'
go

-- If the table already exists drop it.
if exists
    (select table_name
     from information_schema.tables
     where table_name='analysis_outcomes')
    drop table analysis_outcomes

go

-- Create the table analysis_outcomes.
create table analysis_outcomes
    ( memberid int primary key,
--
    basecosts numeric(8,2),
    resultcosts numeric(8,2),
    deltacosts int,
--
    base_er int,
result_er    int,
base_ip      int,
result_ip    int,

--

hypchange    int,
dyschange    int,
eachange     int,
stkchange    int,
renchange    int,
esrdchange   int,
retchange    int,
blindchange  int,
neuchange    int,
amputchange  int

)
go

-- Grant privileges to analysis_outcomes to public.
grant select on analysis_outcomes to public

go

-- Initially populate the analysis table with default values.
insert analysis_outcomes
select distinct
    t1.memberid,
    -1,
    -1,
    -1,
    -1,
    -1,
    -1,
    -1,
    -1,
    -1,
    -1,
    -1,
    -1,
    -1,
    -1
from   segmentation t1
where  t1.studyflag in ('BaseStudy','BaseNoDrug')
go
declare @memberid int
declare @basefirstdt datetime
declare @baseenddt datetime
declare @resultfirstdt datetime
declare @resultenddt datetime
declare @period char(6)

declare analysis_cursor CURSOR
FOR

select distinct
    t1.memberid,
    t2.firstdate,
    dateadd(dd,364,t2.firstdate),
    dateadd(dd,365,t2.firstdate),
    '7/31/2003',
    'result'
from segmentation t1,
     patient t2
where t1.memberid=t2.memberid and
    t1.studyflag in ('BaseStudy','BaseNoDrug')
order by 1

open analysis_cursor
fetch next from analysis_cursor
into     @memberid, @basefirstdt, @baseenddt, @resultfirstdt, @resultenddt, @period

while @@fetch_status=0
begin
    -- COSTS
    -- Determine the total costs for this patient in the base year
    declare @bc numeric(8,2)
    declare @mc numeric(8,2)
    declare @dc numeric(8,2)
    exec proc_costs @memberid, @basefirstdt, @baseenddt,
    @medcosts=@mc output,
    @drugcosts=@dc output,
    @totcosts=@bc output

    update analysis_outcomes
    set basecosts=@bc
    where memberid=@memberid

    -- Determine the total costs for this patient in the result period
    declare @rc numeric(8,2)
declare @rmc numeric(8,2)
declare @rdc numeric(8,2)
exec proc_costs @memberid, @resultfirstdt, @resultenddt,
    @medcosts=@rmc output, 
    @drugcosts=@rdc output, 
    @totcosts=@rc output

update analysis_outcomes
set resultcosts=@rc
where memberid=@memberid

-- Determine the cost delta for this patient from the base to the result period
declare @basedays int
declare @resultdays int

select @basedays = (select datediff(dd,@basefirstdt,@baseenddt)+1)
select @resultdays = (select datediff(dd,@resultfirstdt,@resultenddt)+1)

declare @baseavg numeric(6,2)
declare @resultavg numeric(6,2)

select @baseavg = (select @bc/@basedays)
select @resultavg = (select @rc/@resultdays)

if @resultavg > (@baseavg * 1.173)
    begin
        update analysis_outcomes
        set deltacosts = 1
        where memberid=@memberid
    end
else
    begin
        update analysis_outcomes
        set deltacosts = 0
        where memberid=@memberid
    end

-- UTILIZATION
-- Determine the number of er and ip visits for this patient in the base period
declare @baseer int
declare @baseip int
exec proc_utils @memberid, @basefirstdt, @baseenddt, 
    @er=@baseer output, 
    @ip=@baseip output

update analysis_outcomes
set base_er=@baseer
where memberid=@memberid

update analysis_outcomes
set   base_ip=@baseip
     where  memberid=@memberid

-- Determine the dyslipidemia status for this patient at the end of the base year
declare @resulter int
declare @resultip int
exec   proc_utils @memberid, @resultfirstdt, @resultenddt, @er=@resulter output,
                                  @ip=@resultip  output
update analysis_outcomes
set   result_er=@resulter
     where  memberid=@memberid

update analysis_outcomes
set   result_ip=@resultip
     where  memberid=@memberid

-- HEALTH CHANGE
 -- Determine the hypertension status for this patient at the end of the base year
declare @hypbflag int
select @hypbflag = (select t1.hypertension
                              from   analysis_factors t1
                              where  t1.memberid=@memberid)

-- Determine the hypertension status for this patient at the end of result period
declare @hyprflag int
select @hyprflag=0
exec  proc_hypertension  @memberid,
                              @resultfirstdt,
                              @resultenddt,
                              @period,
                              @hytenflag=@hyprflag output

-- If the hypertension status has changed set the hypertension change flag
if @hyprflag > @hypbflag
begin
      update analysis_outcomes
      set       hypchange = 1
      where     memberid=@memberid
end
else
begin
      update analysis_outcomes
      set       hypchange = 0
      where     memberid=@memberid
end

-- Determine the dyslipidemia status for this patient at the end of the base year
declare @dysbflag int
select  @dysbflag = (select  t1.dyslipidemia
from analysis_factors t1
where t1.memberid=@memberid)

-- Determine the dyslipidemia status for this patient at the end of result period
declare @dysrflag int
select  @dysrflag=0
exec  proc_dyslipidemia  @memberid,
     @resultfirstdt,
     @resultenddt,
     @period,
     @dyslipflag=@dysrflag output

-- If the dyslipidemia status has changed set the dyslipidemia change flag
if @dysrflag > @dysbflag
begin
    update analysis_outcomes
    set dyschange = 1
    where memberid=@memberid
end
else
begin
    update analysis_outcomes
    set dyschange = 0
    where memberid=@memberid
end

-- Determine the cardiac status for this patient at the end of the base year
declare @carbflag int
select  @carbflag = (select  t1.cardiac
from analysis_factors t1
where t1.memberid=@memberid)

-- Determine the cardiac status for this patient at the end of result period
declare @carrflag int
select  @carrflag=0
exec  proc_cardiac  @memberid,
     @resultfirstdt,
     @resultenddt,
     @period,
     @cardflag=@carrflag output

-- If the cardiac status has changed set the cardiac change flag
if @carrflag > @carbflag
begin
update analysis_outcomes
set carchange = 1
where memberid=@memberid
end
else
begin
update analysis_outcomes
set carchange = 0
where memberid=@memberid
end

-- Determine the stroke status for this patient at the end of the base year
declare @stkbflag int
select @stkbflag = (select t1.stroke
from analysis_factors t1
where t1.memberid=@memberid)

-- Determine the stroke status for this patient at the end of result period
declare @stkrflag int
select @stkrflag=0
exec proc_stroke @memberid, @resultfirstdt, @resultenddt, @period, @strokeflag=@stkrflag output

-- If the stroke status has changed set the stroke change flag
if @stkrflag > @stkbflag
begin
update analysis_outcomes
set stkchange = 1
where memberid=@memberid
end
else
begin
update analysis_outcomes
set stkchange = 0
where memberid=@memberid
end

-- Determine the renal and esrd status for this patient at the end of the base year
declare @renbflag int
select @renbflag = (select t1.renal
from analysis_factors t1
where t1.memberid=@memberid)
declare @esrbflag int
select @esrbflag = (select t1.esrd
from analysis_factors t1
where t1.memberid=@memberid)

-- Determine the renal and esrd status for this patient at the end of result period
declare @renrflag int
select @renrflag=0
declare @esrrflag int
select @esrrflag=0
exec proc_renal @memberid,
                @resultfirstdt,
                @resultenddt,
                @period,
                @renalflag= @renrflag output,
                @esrdflag=@esrrflag output

-- If the renal status has changed set the renal change flag
if @renrflag > @renbflag
    begin
        update analysis_outcomes
        set renchange = 1
        where memberid=@memberid
    end
else
    begin
        update analysis_outcomes
        set renchange = 0
        where memberid=@memberid
    end

-- If the esrd status has changed set the esrd change flag
if @esrrflag > @esrbflag
    begin
        update analysis_outcomes
        set esrdchange = 1
        where memberid=@memberid
    end
else
    begin
        update analysis_outcomes
        set esrdchange = 0
        where memberid=@memberid
    end

-- Determine the retinal and blind status for this patient at the end of the base year
declare @retbflag int
select @retbflag = (select t1.retinal
from analysis_factors t1
where t1.memberid=@memberid)

declare @blibflag int
select @blibflag = (select t1.blind
from analysis_factors t1
where t1.memberid=@memberid)

-- Determine the retinal and blind status for this patient at the end of result period
declare @retrflag int
select @retrflag=0
declare @blirflag int
select @blirflag=0
exec proc_retinal @memberid,
@resultfirstdt,
@resultenddt,
@period,
@retinalflag=@retrflag output,
@blindflag=@blirflag output

-- If the retinal status has changed set the retinal change flag
if @retrflag > @retbflag
begin
    update analysis_outcomes
    set retchange = 1
    where memberid=@memberid
end
else
begin
    update analysis_outcomes
    set retchange = 0
    where memberid=@memberid
end

-- If the blind status has changed set the blind change flag
if @blirflag > @blibflag
begin
    update analysis_outcomes
    set blindchange = 1
    where memberid=@memberid
end
else
begin
    update analysis_outcomes

end
set blindchange = 0
where memberid=@memberid

end

-- Determine the neuro and amputation status for this patient at the end of the base year
declare @neubflag int
select @neubflag = (select t1.neuro
from analysis_factors t1
where t1.memberid=@memberid)

declare @ampbflag int
select @ampbflag = (select t1.amputation
from analysis_factors t1
where t1.memberid=@memberid)

-- Determine the neuro and amputation status for this patient at the end of result period
declare @neurflag int
select @neurflag=0
declare @amprflag int
select @amprflag=0
exec proc_neuro @memberid,
@resultfirstdt,
@resultenddt,
@period,
@neuroflag=@neurflag output,
@amputflag=@amprflag output

-- If the neuro status has changed set the neuro change flag
if @neurflag > @neubflag
begin
update analysis_outcomes
set neuchange = 1
where memberid=@memberid
end
else
begin
update analysis_outcomes
set neuchange = 0
where memberid=@memberid
end

-- If the amputation status has changed set the amputation change flag
if @amprflag > @ampbflag
begin
update analysis_outcomes
set amputchange = 1

where memberid=@memberid
end
else
begin
    update analysis_outcomes
    set amputchange = 0
    where memberid=@memberid
end

-- Get the next patient to process
fetch next from analysis_cursor into @memberid,
    @basefirstdt, @baseenddt,
    @resultfirstdt, @resultenddt,
    @period
end

close analysis_cursor
deallocate analysis_cursor
go

update processcontrol
set endtime=(select getdate())
where task='outcomes'
go
use diabetes

-- Location: PhD\Structures\Stored Procedures
-- File: proc_costs.sql
-- Author: Kenn B. Daratha
-- Date: 2-26-2004
--
-- Purpose: Creates a stored procedure to input the parameters of memberid and the
-- range date and return the total drug and medical claims costs this patient
-- had within this time period.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_costs' AND type = 'P')
    DROP PROCEDURE proc_costs

CREATE PROCEDURE proc_costs
    @member int,
    @firstdt datetime,
    @enddt datetime,
    @medcosts numeric(8,2) output,
    @drugcosts numeric(8,2) output,
    @totcosts numeric(8,2) output
AS

-- Check medical claims for total medical and drug claims cost

select @drugcosts = (select sum(paidamt)
    from drugclaim t1
    where t1.fromdate between @firstdt and @enddt and
        t1.memberid=@member)
if @drugcosts is null
begin
    select @drugcosts=0
end

select @medcosts = (select sum(paidamt)
    from medicalclaim t1
    where t1.fromdate between @firstdt and @enddt and
        t1.memberid=@member)
if @medcosts is null
begin
    select @medcosts=0
end
end

select @totcosts = (@drugcosts + @medcosts)
go
use diabetes

go

-- Location:   PhD\Structures\Stored Procedures
-- File:       proc_utils.sql
-- Author:     Kenn B. Daratha
-- Date:       2-26-2004
--
-- Purpose:    Creates a stored procedure to input the parameters of memberid and the
date range and return the total acute care events this patients had within
the specified time period.

IF EXISTS (SELECT name FROM sysobjects
    WHERE name = 'proc_utils' AND type = 'P')
    DROP PROCEDURE proc_utils
    go

CREATE PROCEDURE proc_utils
    @member  int,
    @firstdt datetime,
    @enddt   datetime,
    @er      int output,
    @ip      int output
AS

-- Check medical claims for emergency department and inpatient acute care utilization
    select @er =
    (select count(distinct(t1.fromdate))
        from medicalclaim t1
        where t1.memberid=@member and
            t1.fromdate between @firstdt and @enddt and
            t1.claimtype='u' and
            t1.revcode = '00450' and not exists
                (select 1
                    from medicalclaim t2
                    where t2.memberid=@member and
                        t2.fromdate=t1.fromdate and
                        t2.claimtype='u' and
                        (t1.revcode between '00100' and '00160' or
                            t1.revcode between '00200' and '00214')
                ))

    select @ip =
    (select count(distinct(t1.fromdate))

from medicalclaim t1
where t1.memberid=@member and
t1.fromdate between @firstdt and @enddt and
t1.claimtype='u' and
(t1.revcode between '00100' and '00160' or
t1.revcode between '00200' and '00214')

GO
APPENDIX B.23 – SOM SAMPLE SCRIPT

% Location: Phd\Analysis\Change Variables\% File: Macro.m% Author: Kenn B. Daratha% Date: 2/3/2004% Purpose: This script reads an ascii text datafile, normalizes continuous variables,% trains a self-organizing map and displays the u-matrix and components.% For audit purposes all labels are stored for each neuron.

% Read the data
clear
clf
sD=som_read_data('Macro_BaseRemoved.dat');

% Normalize all variables in the range 0 to 1
sD=som_normalize(sD,'range', [1 4 5 9]);

% Train the Map
sM=som_make(sD)
sM=som_autolabel(sM,sD,'vote')

% Display the unified distance matrix
figure(1)
som_show(sM,'umat','all','norm','n')
som_show_add('label',sM)

% Display all components used in building the unified distance matrix
figure(2)
som_show(sM,'umat','all','comp','all','norm','d')

% Store all labels for each neuron
sM=som_autolabel(sM,sD,'all')
## APPENDIX C.1 – DEFINITION OF PROFESSIONAL VISIT

<table>
<thead>
<tr>
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<th>CPT4 SHORT DESCRIPTION</th>
<th>RBRVS VALUE</th>
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## APPENDIX C.2 – DEFINITION OF EYE EXAM VISIT

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### APPENDIX C.3 – DEFINITION OF PSYCHIATRIC OFFICE VISIT

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## APPENDIX D.1 – DEFINITION OF HYPERTENSION

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## APPENDIX D.2 – DEFINITION OF DYSLIPIDEMIA

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### ACUTE MYOCARDIAL INFARCTION

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| 101   | 4110        | POSTMYOCARDIAL INFARCTION SYNDROME |
| 101   | 4111        | INTERMEDIATE CORONARY SYNDROME |
| 101   | 41181       | OTHER ACUTE AND SUBACUTE FORMS OF ISCHEMIC HEART DISEASE, ACUTE ISCHEMIC HEART DISEASE, ACUTE ISCHEMIC HEART DISEASE |
| 101   | 41189       | OTHER ACUTE AND SUBACUTE FORMS OF ISCHEMIC HEART DISEASE, OTHER |
| 101   | 412         | OLD MYOCARDIAL INFARCTION |
| 101   | 413         | ANGINA PECTORIS |
| 101   | 4130        | ANGINA DECUBITUS |</p>
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## APPENDIX D.4 – DEFINITION OF STROKE

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**ACUTE CEREBROVASCULAR DISEASE**

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## APPENDIX D.5 – DEFINITION OF NEPHROPATHY

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### APPENDIX D.6 – DEFINITION OF RETINOPATHY

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### APPENDIX D.7 – DEFINITION OF NEUROPATHY

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#### SKIN AND SUBCUTANEOUS TISSUE INFECTIONS

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#### OTHER CONNECTIVE (LEA)

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### APPENDIX D.8 – DEFINITION OF MAJOR DEPRESSIVE DISORDER

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Ref Type: Abstract


Ref Type: Generic


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Ref Type: Electronic Citation


Ref Type: Generic


Ref Type: Electronic Citation


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