DIABETES MELLITUS AND HOSPITAL UTILIZATION IN THE PROVINCE OF MANITOBA 1991/92

BY

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ABSTRACT

Attempts to mobilize a more aggressive national prevention and treatment program for diabetes mellitus have been slow to develop and have been compromised by the absence of population-based data. This study used population-based Manitoba Health Claims data to measure diabetes prevalence, hospital utilization and mortality for the fiscal year 1991-92.

A cohort of 45,117 persons with diabetes were identified, of whom 20,496 (45%) were hospitalized.

Standardized comparisons between the diabetic and non-diabetic population revealed a greater than two fold increase in the use of hospital beds by persons with diabetes. This increased bed use was related to higher rates of admission, readmission and longer lengths of stay. Excess diabetes hospitalization was pervasive and hospital-wide in its scope, and remained consistent regardless of length of stay, discretionary nature of admitting diagnosis, intensity or complexity of care, region or treaty status. Analysis of complication-specific hospital bed use demonstrated that admissions for cardiovascular disease, stroke and extremity complications accounted for much of the excess hospitalization in the diabetic population, particularly in rural and Aboriginal populations. Assessment of mortality demonstrated that diabetes was associated with a two- fold excess premature mortality.

This methodology provides a rapid, cost-effective means by which diabetes burden may be identified and subsequently targeted.

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1. INTRODUCTION

Diabetes mellitus is associated with a significant and pervasive adverse impact on health status. This disease imposes formidable and inconvenient treatment and lifestyle demands, acute metabolic decompensations and chronic multi-system complications. Current improvements in education and treatment regimens have contributed toward a reduction in acute metabolic crises and have the potential to alleviate future long-term sequellae.[1] However, diabetes mellitus continues to be the major cause of adult blindness and renal failure in North America. The presence of peripheral neuropathy and peripheral vascular disease associated with diabetes account for the majority of non-traumatic limb amputations world wide. Myocardial infarction is three to four times as common in the person with diabetes as compared to the general population. Gestational diabetes has been associated with a six fold increase in neonatal complications and a four fold increase in congenital malformations. Diabetes is associated with unacceptable levels of premature mortality, disability, work absenteeism, and social isolation.

The magnitude of this chronic disease has spurred a significant basic and epidemiologic research initiative, aimed at improving preventive and therapeutic strategies and the delivery of these strategies to the community. Measuring the effectiveness of these interventions has been described in terms of a complex iterative loop.[2] This loop begins with the description of some aspect of health, followed by studies which attempt to describe etiology and efficacious methods of control. A specific health care program may then be implemented partly justified on the basis of these prior studies, with subsequent assessment of community effectiveness and efficiency, followed by monitoring and eventually reappraisal of illness burden. Unfortunately, diabetes mellitus is one example of the failure to complete this iterative loop through the assessment of health care delivery on a community-wide basis. The past three decades have witnessed an impressive accrual of publications dissecting the pathogenesis of diabetes on a molecular level together with florid epidemiologic descriptions of its long-term complications as described above. Unfortunately, few studies have taken the assessment process further and most have neglected to measure the effectiveness of community services for diabetes.

The reasons for this failure are multi-factorial and include such issues as the immense size and complexity of diabetes services, considerable costs associated with measuring illness burden on a population-wide basis, lack of clear program goals, the reductionist approach of traditional medicine (which is largely organ-system based) and persistent academic emphasis on the experimental method. The experimental method may be easily applied in basic science and the randomized clinical trial, in clinical science. However, the "scientific method" often is neither appropriate nor ethical in circumstances where efficacious interventions are being assessed in the community.

This study was designed to measure diabetes hospitalizations in the province of Manitoba on a population wide basis. Hospitalizations were chosen as the measurement objective as these hospitalizations reflect the effectiveness of diabetes care in the community and comprise the greatest proportion of the health care budget devoted toward management of diabetes. Now that a large number of effective community preventive therapies have been identified, a certain proportion of these hospitalizations reflect the ultimate cost of inadequate prevention.

Administrative claims data was used as the tool for measuring diabetes hospitalizations. This has previously been used in the United States as a technique for assessing the effectiveness of diabetes care in the community[3]. The Province of Manitoba has an administrative claims data base which is ideally suited to identification of persons with diabetes and their subsequent hospitalization experience.[4,5,6,7]

This retrospective cross sectional study utilized the Manitoba Health data base in order to:

1. Measure the prevalence of diabetes mellitus in Manitoba and to relate this prevalence (in the City of Winnipeg) to socioeconomic status.
2. Compare patterns of hospital utilization and mortality between diabetic and non-diabetic populations
3. Compare the impact of treaty status on patterns of hospital utilization for diabetic and non-diabetic populations.
4. Measure hospital utilization for various diabetes complications and to relate these to urban residence (Winnipeg vs Non-Winnipeg), health region and treaty status.

Research conducted in this fashion has the potential to identify specific diabetic populations where improvements in the delivery of preventive and therapeutic strategies are required. The implementation of these strategies and subsequent periodic measurement of hospitalization experience using an administrative database is one means by which the iterative loop of health care outcomes measurement may be completed in an objective and repetitive cycle.

2. REVIEW OF THE LITERATURE

2.0 i) Overview of Diabetes Hospital Utilization

Diabetes mellitus (DM) is a metabolic disorder characterized by hyperglycemia secondary to defective insulin secretion, insulin action or both. It has recently been reclassified into the following four types:

1. Type I DM - characterized by pancreatic beta-cell destruction with subsequent hypo-insulinemia and ketoacidosis.
2. Type II DM - characterized by marked insulin resistance and usually hyper-insulinemia but with eventual reduction in insulin secretion.
3. Gestational Diabetes - characterized by glucose intolerance during pregnancy.
4. Other specific types characterized by a miscellaneous but long list of rare causes of hyperglycemia.

New diagnostic criteria and management recommendations have recently been published in the latest Clinical Practice Guideline for the Management of Diabetes Mellitus published by the Canadian Diabetes Association.[8] The optimal management of diabetes requires a profound commitment on the part of the patient to carry out self-management by balancing difficult life-style changes and therapies. Historically, much of this was achieved through the delivery of care in a hospital-based system, but increasingly the focus has been on providing the skills needed for self -care through the support of an interdisciplinary team of health professionals known as a 'diabetes health care team'. The World Health Organization made the recommendation in 1980 that "health care for the diabetic should be incorporated into community-based health care systems with appropriate additional facilities available at all levels of care".[9] This change in the organization of diabetes care has emerged rather heterogeneously over the past one to two decades, and few studies have attempted to profile the delivery of diabetes services in the community, particularly on a population-wide basis. This is of particular concern as the availability of an interdisciplinary diabetes health care team is far from uniform from community to community; the resources required to shift the focus of diabetes care from the hospital to a self-care model with community support have been suboptimal. The analysis of diabetes related hospitalizations is one means of reviewing the effectiveness of out-patient care, as suboptimal care in the community has been correlated with increased hospitalization rates.[10,11]

Data from the United States and the United Kingdom during the past three decades indicate that a diabetic spends an average of five to six days per year in hospital, which is five times the national average.[10,12] Figures such as these have been used as justification for higher health insurance premiums for persons with diabetes in the United States. Miller et al were able to demonstrate that improvements in the effectiveness of community diabetes care could reduce the annual days of hospitalization to 1.2 days.[10] A similar diabetes program at Grady Memorial Hospital in Atlanta has demonstrated a 78% reduction in hospitalizations for severe diabetic ketoacidosis, improvement in glycemic control without increased episodes of hypoglycemia and a 50% reduction in leg amputations.[11] Similar findings have also been demonstrated with the Memphis Chronic Disease Program.[13]

These impressive achievements have largely been documented at hospital based, multi-disciplinary out-patient programs. Quality of diabetes care in general practice versus hospital clinics has been scrutinized in several contradictory reports. Hayes and Harris have documented significant outcome differences in two comparable groups of well controlled patients with Type II diabetes mellitus, randomly allocated to general practice or hospital clinics.[14] The general practice group demonstrated poorer outcomes with less intensive clinical follow up, inferior glycemic control, increased mortality and increased hospital admissions. The literature also indicates that simple maneuvers can adjust the process and pattern in general practice clinics such that there is little discrepancy in quality of care between these and hospital-based clinics.[15] Improvements in outcome may be linked more with the implementation of educational and multi-disciplinary approaches to care rather than to where the care is delivered, whether it be in the community or in the hospital-based setting.

Various investigators have attempted to determine where barriers exist to the appropriate delivery of care for diabetes in the community. Hiss reviewed Type II diabetes care in eight different Michigan communities from 1988 to 1994 (1056 patients).[16] It was observed that primary care physicians were visited 3.7 times per year but only 33% of all patients received what was felt to be essential diabetes care services during that time. Factors contributing to suboptimal care were felt to be that diabetes was not considered or managed as a serious problem and that a multi-system chronic illness such as diabetes fits poorly in a health care system designed to deal with acute illness.

The 1989 National Health Interview Survey in the United States (NHIS) documented that 90% of diabetic adults had one physician for their usual diabetes care and 32% made less than 4 visits per year to this doctor.[17] Diabetes specialists were seldom visited nor were other health care professionals such as ophthalmologists, podiatrists, nutritionists and diabetes educators. Approximately 40-50% of those taking insulin and 5% of those not taking insulin monitored their blood glucose level daily. The author concluded that the medical care for diabetic patients and their self-care practices were suboptimal for preventing long term complications.

Several studies of diabetes hospital utilization have demonstrated rising admission rates over time and significant unexplained differences across regions.[1,18] An early study indicated that diabetes (as principal diagnosis) accounted for less than 1% of hospital in-patient days in 1975.[19] This data was highly flawed, however, as subsequent studies have demonstrated that over 50% of diabetes admissions are only documented as a subsidiary diagnosis, usually with cardiovascular disease listed as the primary diagnosis.[12] A more recent study has shown that when diabetes is listed as primary or subsidiary diagnosis, it contributes to at least 3.6% of total hospital admissions, with lengths of stay longer than for non-diabetic persons (13.6 vs 11.3 days).[20]

The Centers for Disease Control, (CDC) state-based diabetes control program in the United States probably is the largest nationally based effort to obtain information on hospitalizations and outcomes in diabetes.[1] This program has been used to demonstrate that a progressive reduction in diabetes mortality rates has occurred over time, particularly deaths associated with diabetic ketoacidosis or coma, and improvements in education and therapy have been made. A study from the UK has demonstrated that while hyperglycemic complications appear to be decreasing, acute hospitalizations related to treatment induced hypoglycemia have been increasing.[21] It is has been postulated that this may represent recent trends towards optimizing glycemic control. CDC data has also shown that chronic complications such as amputation continue to increase both in terms of absolute number and relative rates.[1] CDC data has also been used to define risk factors for the development of diabetes, including age, ethnic minority status and low socioeconomic level.

While these population-based studies appear to be providing important information related to diabetes care in the community, they have been few in number. Canada for example has no national diabetes surveillance program. The paucity of pertinent outcomes data from the community may be related to methodologic impediments associated with data acquisition.[22] Primary data collection has the potential to provide rich detail but has seldom been performed, as it is time-consuming and expensive. This method seldom permits the study of large populations, and is therefore unable to demonstrate reliable annual trends. The use of secondary data (usually gathered for administrative purposes) is compromised by significant undercodeing of diabetes on hospital discharge forms, idiosyncratic changes in coding based on payment modalities and lack of clinical detail. Most studies, including the CDC surveillance program, are event-based rather than patient-based. Outcome measures such as amputation are therefore tallied as amputations per 1000 diabetes discharges rather than amputees per 1000 diabetes discharges. Many population-based studies are carried out on inadequate samples of patients, with limited linkage of different data files and are therefore unable to measure hospital utilization and outcomes in a comprehensive fashion.[21]

The status of community-based diabetes health care initiatives has been seldom studied in Canada and population-based measures have been rarely applied.

2.1 DIABETES PREVALENCE AND INCIDENCE

The most global estimate of diabetes prevalence in adults was published by King in 1993.[23] Raw data was collected by obtaining oral glucose tolerance screening tests between 1976 to 1991 in over 150,000 persons from 32 countries. This study was the first to clearly document that diabetes was a world wide health problem and also that its prevalence varied incredibly from community to community. Diabetes was rarely found in traditional communities such as the rural Bantu in Tanzania (1%), moderately common in widespread parts of the world including Asia, United States and Europe (3 - 10%), and extremely prevalent (11 - 20%) in migrant Asian populations, US black women, Fijians, and Australian Aborigines. The highest prevalence was seen in Pima Indians and Micronesians (40 - 50%). A marked excess prevalence of diabetes was apparent in developing countries where traditional societies were becoming increasingly urbanized, either locally or through emigration, while disadvantaged communities appeared to be at highest risk in industrialized countries.

Several studies in the United States have reported the prevalence of diabetes mellitus in adults and these studies have demonstrated that a self-reported diagnosis underestimated the true prevalence of diabetes by at least 50%.[24,25] The NHANES II survey also revealed that for every person in the United States with diabetes there was another with undiagnosed diabetes.[25] In this study the prevalence of undiagnosed diabetes was 3.2% and that of previously diagnosed diabetes was 3.4% in the 20-74 year old population. The CDC's national health interview survey (NHIS) 1997 report has shown that the incidence and prevalence of self-reported diabetes has continued to rise over the past decade and that most of this increase is unrelated to aging in the United

States population.[26] This is further supported by a population-based retrospective study from Rochester, Minnesota which has demonstrated that the age adjusted prevalence of Type II diabetes has risen 65% for men and 37% for women between 1970 and 1990.[27]

There are no national prevalence data regarding Type II diabetes mellitus in Canada. The best population-based data has been derived from the Manitoba Health database. This work has identified a prevalence of 0.8% among those aged 25 to 44, 3.5% among those 45-64 and 7.6% for those 65 and older (1980-1984).[4] The annual incidence of diabetes mellitus for those over age 25 was 7.8/1000. A repeat study using this database for the years 1986 to 1991 has shown a gradual rise in age adjusted prevalence of diabetes both for men and women with an average prevalence of 6.7% among adults greater than 25 years of age in 1991.[6] The incidence of diabetes in Manitoba has gradually declined and plateaued during the 1980s and the current incidence of diabetes has remained stable at 5.6 cases per 1000. The Manitoba Heart Health Survey used the criteria of self-reported diagnosis of diabetes and/or fasting plasma glucose greater than or equal to 7.8mmol/l to identify a prevalence of 6% amongst adult Manitobans.[28] This correlated well with the data obtained using administrative health care data.

2.2 Diabetes Outcomes

The primary importance of measuring diabetes outcomes is related to the unacceptable morbidity and mortality associated with diabetes. Many studies dealing with diabetes care have examined the process of care using such parameters as length of stay, bed occupancy, turn-over interval and throughput.[20,29] The end result has been an assessment of activity rather than outcome. Greater potential benefits are likely to be realized in the future by relating the structure and process of diabetes services to important outcomes. A brief review of some of these important outcomes follows.

2.2.0 Nephropathy

The Diabetes Burden of Illness Study in Manitoba has revealed that the rate of initiation of dialysis is 10 times higher amongst persons with diabetes and this disease accounts for 35% of newly initiated dialysis.[30] These figures are almost identical to those found in the United States, Europe and Japan. Once a diabetic begins dialysis, their five year survival is much worse than for non-diabetics with renal failure (26 versus 45 percent in United States patients, 31 versus 55 percent in European patients).[31] Most of this excess mortality is due to myocardial infarction, which is nearly ten times higher than for non-diabetics with end stage renal disease (ESRD).[32] Post renal transplant mortality is 60% higher in diabetic patients compared to others.[33]

Although progressive diabetic nephropathy is now the leading cause of end-stage renal failure in Canada, there is increasing evidence that the rate of progression may be significantly reduced through multiple interventions.[34] These interventions include improved glucose control, low protein diet, improved blood pressure control, and treatment with an angiotensin converting enzyme (ACE) inhibitor. The Diabetes Control and Complications Trial (DCCT) revealed that diabetic nephropathy risk could be reduced by 56% in young Type I diabetics receiving intensive insulin therapy.[35]

The best early clinical predictor of diabetic nephropathy is urinary microalbumin excretion rate. Savage et al have indicated that amongst persons with Type II diabetes mellitus, increasing albumin excretion rates are also associated with an increased prevalence of diabetic retinopathy, neuropathy and cardiovascular disease.[36] This test therefore may reflect a state of generalized vascular damage rather than being an indicator of renal disease alone, and may be a useful indicator of treatment effectiveness.

The direct health care cost in the United States for diabetic persons with end-stage renal disease has been estimated at approximately one billion dollars per year.[37]

2.2.1 Diabetic Retinopathy

Diabetic retinopathy is a highly specific microvascular complication which can be found in both Type I and Type II diabetes mellitus. Its prevalence is closely related to the duration of diabetes and by twenty years after onset, nearly all patients with Type I diabetes, and greater than sixty percent of those with Type II, have some degree of retinopathy.[38] The Wisconsin Epidemiologic Study of Diabetic Retinopathy (WESDR) found that 3.6% of Type I diabetics and 1.6% of Type II diabetics were legally blind.[39] Diabetic retinopathy is estimated to be the most frequent cause of new cases of blindness for persons aged 20 to 74 years. The WESDR may be the best population based investigation of diabetic retinopathy to date, and it has suggested that poor glycemic control and hypertension are primary risk factors related to proliferative retinopathy.[40] These studies have also shown that by the time retinopathy has developed, there is a significant risk that other end-organ diabetic complications have occurred. The DCCT revealed that for young persons with Type I diabetes, the risk of retinopathy could be reduced by 76% over a follow-up period of 6.5 years.[35] A randomized clinical trial has shown over a 36 month period that panretinal photocoagulation leads to a 50% reduction in advancement to severe visual loss.[41]

Screening guidelines have been developed for detecting diabetic retinopathy, but despite these guidelines and the findings above, recent studies suggest that many people are being neither screened nor treated in a timely fashion.[42,43]

There are few population-based studies measuring blindness in diabetes. A German study by Icks et al has shown an incidence of blindness of 60.5 per 100,000 persons with diabetes per year.[44] Javitt has shown that screening and treatment of eye disease in persons with diabetes costs $3,190.00 per quality adjusted life year saved.[45]

2.2.2 Diabetic Neuropathy and Limb Loss

Essentially any nerve may be involved with diabetic peripheral neuropathy and the myriad manifestations of diabetes in the peripheral nervous system is such that this is a complex topic. The prevalence of this complication varies with the diagnostic test used; hence its true prevalence is unknown. The most rigorous scoring system is likely the combined score developed in the Rochester Diabetic Neuropathy Study cohort.[46]

In one longitudinal study, the prevalence of neuropathy at time of diagnosis of diabetes was 8%, increasing to 50% after 25 years.[47]

The most common manifestation of diabetic peripheral neuropathy is a distal symmetric sensory motor neuropathy, which tends to reduce sensation in a stocking distribution and produce foot deformity. This is a major risk factor for foot ulceration and amputation in this population. The sensation of pain traditionally has been an important means by which a patient communicates problems to their physician. This lack of pain sensation leads not only to unrecognized tissue breakdown, but also significant breakdown in physician/patient communication.

Despite the complexities involved in documenting neuropathy for research purposes, it has been shown that a simple screening technique using a Semmes-Weinstein nylon monofilament is an excellent means for detecting "protective foot sensation". Diabetic foot ulceration, infection and amputation are continuing to increase in both relative and absolute numbers in the United States, in spite of the presence of this screening technique and the fact that simple preventive maneuvers can reduce foot complications.[48] The DCCT revealed that neuropathy risk may be reduced in 60% of persons with tight glucose control.[35] However, more practical and effective means of reducing amputation are related to patient education and appropriate foot wear. Studies over the past decade have shown that even in specialized diabetes clinics, feet are examined by physicians in only 10 to 15% of patients.[49] Diabetes is now the number one cause of limb loss in North America. At least ten large population-based amputation studies have been carried out and are reviewed in Table 1.[1,50-58] The yearly amputation rate in these studies has varied between 2.9 and 13.7 per 1,000 persons with diabetes. These studies have also indicated that the risk of amputation in diabetes mellitus is approximately 15 times greater than that of the general population.

The three year survival following an amputation for persons with diabetes is only 50% and for those who have had one amputation, the risk of losing the contralateral leg at four years is 53%.[59]

Wide small area variation in amputation incidence has been documented repeatedly, suggesting that unnecessary amputations are being performed.

The direct cost of a lower extremity amputation was estimated at between $8,000.00 to $12,000.00 by the American Diabetes Association in 1983, with

TABLE 1

DIABETES AND THE INCIDENCE OF AMPUTATION

REFERENCE	REGION	YEARS	AMPT/100,000 POPULATION	AMPT/1000 WITH DIABETES
50	SWEDEN (GOTLAND)	1971-1980	20.5	-
50	SWEDEN (UMEA)	1971-1980	6.5	-
51	DENMARK	1981	11.0	-
51	DENMARK	1989	7.0	-
52	FINLAND	1978-1984	26.7	2.9
53	UK (NEWCASTLE)	1989-1991	7.4	7.4
54	UK (TAYSIDE)	1980-1982	8.4	10.5
55	CANADA (ONTARIO)	1987-1988	-	4.4
56	USA (PIMA)	1972-1984	206	13.7
57	USA (6 STATES)	1976-1978	-	5.9
58	USA (WISCONSIN)	1980-1986	-	5.5
1	USA (CDC)	1980-1989	-	8.4

acknowledgment that this is a gross underestimation of current costs, particularly as indirect costs outweigh the direct ones.[60]

Statistically significant factors which increase risk for amputation include peripheral vascular disease, peripheral neuropathy, low levels of high density lipoprotein, lack of prior out-patient diabetes education, foot ulceration, diastolic hypertension, elevated glycosylated hemoglobin level, retinopathy, increased duration of diabetes, male gender and proteinuria.[61] This would suggest multiple preventive modalities could be employed to reduce amputation burden such as improving foot care education, revascularization and lipid lowering therapy.

2.2.3 Peripheral Vascular Disease

The prevalence of peripheral vascular disease is significantly increased in persons with diabetes. One study followed 619 patients from the time of diagnosis, and at 13 years follow-up determined that the cumulative risk for intermittent claudication was 31% and non-palpable dorsalis pedis pulse 35%. [62]

The pattern of peripheral vascular disease is unique in diabetics when compared to non-diabetics who have peripheral vascular disease. The pattern in diabetes tends to be distal (infrapopliteal distribution), symmetric and has multiple regions of stenosis, while in the latter group disease tends to be confined to aortoiliac and femoral distributions, and is often unisegmental and unilateral in distribution.[63]

The presence of peripheral vascular disease is strongly correlated with concurrent and often occult coronary artery disease; the risk factors for coronary and peripheral vascular disease appear to be the same. The relative risk for intermittent claudication in the Framingham Study was four to five times greater for diabetics after adjusting for blood pressure, cholesterol and smoking and therefore the presence of diabetes is a highly significant risk factor.[64] The risk for peripheral vascular disease increases with duration of diabetes and can be found in 8% of persons at the time of diagnosis and 45% after twenty years.[65] Smoking doubles the risk of intermittent claudication and hypertension increases the risk 2.5 to 4 times.[64] Elevated cholesterol is likely a significant independent risk factor also; this has been further suggested by the Scandinavian Simvastatin Survival Study which has demonstrated decreased claudication with lipid lowering therapy.[66] Therefore, there are well documented factors which can be modified to reduce the risk of peripheral vascular disease. Vascular disease is a major risk factor for amputation, and the subsequent provision of bypass surgery when required, can be considered a limb saving procedure in persons with critical limb ischemia.

A population-based longitudinal study of persons with critical leg ischemia in Sweden studied patients who were admitted for a key extremity surgical procedure.[67] Patients were found to require an average of 3 (range 1 to 19) surgical procedures during their stay with a mean length of stay of 117 days (range 1-1,097). The total hospital and surgical costs among these 321 patients was $15,100,000 (US) or $47,000 per patient. Persons with critical leg ischemia, therefore, accumulate long hospital stays associated with very high, long term costs. Only a small proportion of the duration of their hospitalization is spent in surgical departments and hence length of stay and costs have probably been grossly underestimated in previous studies which have only looked at the length of stay on the surgical service.

2.2.4 Coronary Heart Disease

Cardiac disease is the major cause of death in persons with diabetes. Type II diabetes is associated with a two to four fold excess of coronary heart disease compared to non-diabetic populations.[68] Major coronary risk factors include age, hypertension, cigarette smoking, lipid profile and existence and duration of Type II diabetes mellitus. The NIDDM Patient Outcome Research Team has shown poor correlation between cardiovascular disease and hemoglobin A1c quartiles.[69] This had been suggested previously by other studies and the United Kingdom Prospective Diabetes Study (UKPDS) study has shown only a modest reduction in coronary events with improvement in glycemic control.[70,71]

Persons with diabetes have higher rates of silent ischemia. Moreover, following an acute MI, they have higher mortality rates and are at greater risk for congestive heart failure, recurrent infarction and arrhythmia.[72,73]

The Diabetes Burden of Illness Study in Manitoba revealed that 27% of hospitalizations for cardiovascular disease occur in persons with diabetes.[30] Diabetics who have undergone coronary revascularization have increased mortality and morbidity following these procedures. A recent randomized trial has shown that diabetics do far better with surgical revascularization (CABG with at least one internal mammary artery graft) than with percutaneous transluminal coronary angioplasty (5.8% versus 20.6% mortality).[73]

2.2.5 Stroke

For people with diabetes the rate of hospitalization for stroke is between twenty and thirty per thousand per year.[75] The age-adjusted relative risk of stroke is four times higher for diabetics versus non-diabetics. A British study concluded that the cost of cerebrovascular disease hospitalizations was between £1 and 1.6 million /100,000 population, of this, 15% was attributed to persons with diabetes, and it was estimated that 94% of the diabetes related expenditure was potentially avoidable.[75]

Although hypertension has been considered the strongest risk factor for stroke, diabetes may be a stronger independent risk factor, as suggested by a large prospective Finnish study which demonstrated that fatal stroke was increased several fold by diabetes and that of stroke deaths, 16% in men and 33% in women could be attributed to diabetes.[76]

There is also recent evidence supporting an increased risk of dementia in persons with Type II diabetes mellitus which is likely secondary to diabetes related cerebrovascular disease.[77,78]

2.2.6 Infectious Complications

Infection is a common and potentially life threatening complication for persons with diabetes. A defect in the function of polymorphonuclear leukocytes has been the major and most consistent abnormality described in diabetes, and is closely associated with the degree of glycemic control.[79] Impaired neutrophil function plays a significant role in the predisposition to recurrent skin and soft tissue infections, oral cavity infections, and infections of the nose, sinuses and orbit. Diabetics are reported to have a three fold greater risk of bacterial infection than non-diabetics; three-fourths of these are community acquired.[80]

There is an increased risk of symptomatic urinary tract infection (UTI), particularly complicated UTI in these patients, as well as asymptomatic bacteruria.[81] The increased rate of infected foot ulcers has previously been discussed and represents a huge burden of disease. There is an increased risk of necrotizing fasciitis in persons with diabetes and the risk of post-surgical wound infection is also increased at least two fold above the general population.[80]

Diabetes mellitus has been cited as an independent risk factor for developing lower respiratory tract infection, but data regarding this is incomplete. Studies from the first half of the century have shown that approximately 20% of diabetes deaths are due to infection, of these infectious deaths, approximately 50% are due to pulmonary infection.[82] There is growing evidence that there is both an increased frequency and increased mortality for *Staphylococcus aureus*, gram negative bacteria, *Mycobacterium tuberculosis*, fungal infection and influenza in persons with diabetes. These however, are not the most common causes of community acquired pneumonia in the general population, and it has not as yet been firmly established whether the overall incidence of community acquired pneumonia is increased among diabetics. What is clear is that the common causes of community acquired pneumonia are associated with increased morbidity and mortality in diabetics, the most common pathogen being *Streptococcus pneumoniae.*

Poor glycemic control has also been correlated with impaired monocyte and lymphocyte function.[83] This impairment of cell mediated immunity accounts for the increased risk of fungal mucosal infections and tuberculosis reactivation seen in diabetes. This defect also probably accounts for the increased severity and complications associated with varicella zoster infection.[84]

Few population-based studies of diabetes hospitalizations for infection have been published to date. One notable exception is a recent review of excess urinary tract infections in the diabetic population of Manitoba.[81]

2.2.7 Metabolic Complications

The only diabetes hospitalizations which are actually unique to the disease (apart from diabetic retinopathy and nephropathy) are those for diabetic ketoacidosis (DKA) (Type I diabetes mellitus) and non-ketotic hyperosmolar dehydration (Type II diabetes mellitus). Population-based data in the United States has shown that hospitalization rates for diabetic ketoacidosis between 1980 and 1987 have increased by 21%.[48] There were approximately 84,000 DKA associated hospitalizations and 1,800 DKA associated deaths in the United States in 1988. With the publication of the DCCT and consequent aggressive attempts at improving blood sugar levels, an increased risk of hypoglycemia has also been queried. One study has shown that as glycemic control has improved in the Type I diabetic population (as reflected by improved hemoglobin A1C values), there has been a tendency for more severe hypoglycemia.[21] The most severe form of DKA, associated with unconsciousness, did not show an increase in that study. This may be partly related to the difficulties attaining the same level of glycemic control under conditions of routine care as compared to a randomized trial setting. A population-based study of Type I diabetics in Wisconsin has shown that despite a reasonable level of care, 38% of patients had glycated hemoglobin levels associated with risk of significant short term complications.[85]

Hospital utilization for hyperosmolar dehydration in Type II diabetes mellitus has not been examined in detail by population-based studies.

2.2.8 General Medical Complications

Although the expected complications of diabetes mellitus have been studied in population-based studies there has been very little attention given to the increased risk of hospitalization for general medical conditions. This has recently been reviewed in the United States, where greater than 300,000 hospitalizations of middle aged persons with diabetes were compared to over 700,000 non-diabetic hospitalizations.[86] Compared to non-diabetics, diabetics had a 13 fold greater risk of admission with peritonitis/intestinal abscess, a 5 fold greater risk of respiratory failure at admission, a 3 fold increase in hospitalization for liver disease and a 3 fold excess risk for septicemia admissions. Similar findings were reflected in the Mutual of Omaha Current Trends Database, again suggesting that an excess hospitalization risk exists for diabetics for diagnoses not traditionally viewed as "diabetic complications".[3]

A recent study has also demonstrated that persons with diabetes appear to be at higher risk for developing cancers of the liver, biliary tract, pancreas, endometrium and kidney.[87]

2.2.9 Pregnancy Outcomes

Diabetes mellitus (both Type I and Type II) is associated with increased birth defects and perinatal mortality. A recent prospective population-based study has shown that the perinatal mortality rate was 48/1,000 diabetic pregnancies compared to 8.9/1,000 for the general population.[88] The congenital malformation rate was 83/1,000 compared to 21.3 for the non-diabetic population. Data such as this continues to demonstrate that diabetes poses a high risk for fetal complications particularly for women with Type I diabetes. A similar population-based study from the UK has also shown that women with pre-existing Type I diabetes have a 10 fold greater risk of congenital malformations and a 5 fold greater risk of still birth when compared to the general population.[89]

2.2.10 Quality of Life

Diabetes-specific quality of life measures have been developed over the past five years, and these, as well as general measures of quality of life, have shown a pervasive reduction in quality of life in this population.[90,91] Such measurements are difficult to perform on a population wide basis.

2.2.11 Diabetes Mortality

The excess mortality attributable to diabetes is significant. A prospective study essentially following the whole population over age 60 of Fredericia, Denmark from 1981 to 1995 demonstrated that by the end of the study, 74.4% of diabetics and 40.4.% of non-diabetic controls had died.[92] This was approximately 2.5 times that of the non-diabetic population after adjustment for age and gender. Gatling has published similar data from the UK, again demonstrating a 2 fold excess mortality rate in persons with diabetes.[93] The excess mortality associated with Type I and Type II diabetes has been further defined by the World Health Organization Multinational Study of Vascular Disease in Diabetes.[94] This study has also demonstrated that hypertension and proteinuria increase the mortality rate strikingly and that considerable inter-national differences exist in the extent of excess diabetes mortality. This study further highlights the significant underestimation of diabetes mortality obtained in studies relying upon analysis of death certificate data.

2.3 Diabetes Mellitus and Aboriginal Health

Diabetes has reached epidemic proportions in some aboriginal populations; diabetes mellitus was seldom detected prior to the 1940s in these populations.[95] The

Diabetes Burden of Illness Study in Manitoba has demonstrated that in 1991, almost 20% of treaty status adult women and 12% of treaty status adult men had diabetes mellitus, and yearly diabetes prevalence has shown a well documented rise over the past decade. Current Manitoba diabetes incidence rates of 1.5% for Aboriginal women and 1% for men are well above that of the non-Aboriginal population.[35] A recent community-wide prevalence study from Sandy Lake, Ontario, using oral glucose tolerance testing, revealed that the overall crude prevalence rate for Type II diabetes mellitus was 17.25 and increased to 26.15 overall when age standardized to the Canadian population.[96] Females had a higher prevalence of obesity, impaired glucose tolerance and Type II diabetes mellitus at younger ages compared to males.

The prevalence of diabetes amongst Aboriginal communities in North America varies widely. The factors influencing this variation were first described by Dr. Kelly West in 1974 and more recently in an exhaustive review by Young in 1993.[97] Diabetes amongst Aboriginal populations is almost completely due to the Type II variant and is now characterized by earlier age of onset with each generation. In general, the prevalence rates of diabetes amongst natives in Canada exceed that of the non-Aboriginal population except for remote northern and western populations. The etiology of this profound susceptibility to diabetes, which exceeds that of the Caucasian population several fold, appears to be related to a poorly understood and complex interaction between genetic susceptibility and environmental factors.

Diabetes complications in Aboriginal people also have a unique epidemiology. Native diabetics have a significantly increased risk of microvascular complications. The risk of end-stage renal disease secondary to diabetes is increased two and a half to four times above that of non-Aboriginal diabetics.[98] A similar excess risk for retinopathy and blindness appears to be present but has not been as well studied.[99] There is also an excess risk for lower extremity complications and limb loss amongst Aboriginal diabetics which is on average about four times that of the non-native diabetic population in North America.[100] This excess risk may partly reflect an excess prevalence of peripheral neuropathy and peripheral vascular disease in Aboriginal diabetics.

Although rates of microvascular and peripheral vascular complications appear to be increased in Aboriginal diabetics, some studies have indicated a reduced relative rate of coronary disease, which thus far remains unexplained.[101]

2.4 Risk Factors for Diabetes Hospitalization

The determinants of hospitalization in persons with diabetes are complex and require further study. Palta, using the population-based Wisconsin diabetes registry, has shown that for Type I diabetes mellitus, the major risk factors for hospital admission were: deteriorating glycosylated hemoglobin determinations, non-Caucasian race, non-university-based setting and lack of insurance.[102] The overall rate of admission was 8.9 per 100 person years of diabetes; of these 64% were for hyperglycemia, 21% for hypoglycemia and the remainder for miscellaneous causes. The authors in this study concluded that for children and young adults with Type I diabetes, the primary reason for admission was related to problems with glycemic control. The association with non-university based settings suggested that the type of diabetes care in the community may have affected control. Race and economic factors were also suggested as important by this study, and have been noted also from studies of those with Type II diabetes mellitus.

Hospital admissions for persons with Type II diabetes mellitus are less influenced by glycemic control issues, and related more to direct complications of disease. As in Type I diabetes, race, Socio-economic factors and level of care in the community affect admission rates. One study has documented the fact that although social deprivation increases out-patient and hospital utilization for both diabetics and non-diabetics, this factor has a relatively greater influence on diabetes hospitalizations.[103] Examination of social deprivation and cardiovascular risk factors in persons with diabetes has shown that increasing levels of deprivation were significantly related to mean total serum cholesterol, increased proportion smoking, greater body mass index and proteinuria.[104] Social deprivation likely represents a double jeopardy for racial minority groups who have a well documented increased risk for diabetes (independent of socioeconomic status) and who are also more likely to experience greater degrees of social deprivation, increasing the risk for diabetes complications further.

The mode of delivery of health care services to persons with diabetes in the community also appears to play a major role in influencing outcome, with particular evidence of benefit demonstrated for specialized multi-disciplinary diabetes care clinics.[10,11,14,16,105-107] Enhanced outcomes associated with the use of these multi-disciplinary clinics does not necessarily minimize the influence of the patient's family doctor. Singh has demonstrated that the glycemic control provided by family practice out-patient settings compares well with multi-disciplinary hospital based settings.[15] This is a crucial observation, as the health care professionals most visited by persons with diabetes are family physicians.[134] The growing complexity and multi-disciplinary requirements for diabetes care are such, that rather than minimizing the family physician's role, that role may be enhanced. The more health care professionals involved in a patient's care, the more important it may be to have a single coordinating professional to oversee the process of that care. The delivery of out-patient diabetes care is thus highly complex depending upon the experience of the family physician, the structure of the care provided and the physician's access to specialized support services. This may be the reason that one study was unable to demonstrate reduced hospital admissions when comparing general practices which provided structured diabetes care versus those that did not.[135]

As for most medical conditions, large variations in diabetes hospital utilization have been seen between hospitals, communities, health regions, etc.[1,18,108-110] These variations cannot be explained on the basis of variations in diabetes prevalence or availability of hospital beds alone. Factors related to health care structure and morbidity levels also appear to explain little of these regional variations.[108] Some studies have demonstrated that the greater the proportion of diabetic patients in a family physician's practice, the lower the hospital use, suggesting that clinical experience may play a role.[108,111] A microscale analysis of diabetes hospitalization in New Zealand has also suggested that admission rates vary according to the age of the patient's family doctor as well as the practice type and diabetic case load.[111] Recently graduated doctors and those who had small diabetic case loads had higher admission rates in this study. Although there was marked variation in attendance to specialist services and diabetes education, these did not appear to have a significant effect on propensity for hospitalization. This was felt to reflect the complexity of local diabetes care rather than service ineffectiveness. This is probably true, as other studies have demonstrated reduced hospitalization in persons attending specialist clinics and in those motivated enough to present to diabetes education programs.[10,11,13,105,112]

One macro level analysis of diabetes hospital utilization has demonstrated an influence of bed availability on hospital utilization; this positive correlation would confirm the presence of Roemer's Law (i.e. a bed built is a bed filled), at least in terms of macro level variation in hospital admission.[111] However, Aro was unable to demonstrate any significant impact of bed availability on hospital utilization.[108]

2.5 Summary of Literature Review

Diabetes mellitus is now a world-wide health problem which has seen a significant increase in both incidence and prevalence over the past 50 years. Review of diabetes complications has shown that in developed countries, diabetes now accounts for the largest proportion of patients with end-stage renal disease requiring dialysis, adult blindness and limb amputation.[138] These patients are five times as likely to have peripheral vascular disease and two to four times as likely to experience stroke, acute MI, congestive heart failure or pneumonia. Admissions for other conditions not typically associated with diabetes are also uniformly increased.[139] The premature mortality associated with diabetes mellitus has shown a two fold excess increase compared to the non-diabetic population.[92,93,94] Quality of life measurement in this population has shown a pervasive reduction compared to those unaffected by diabetes.[91]

Risk factors for diabetes and complications thereof have been associated with race, socioeconomic status, urbanization and alterations in traditional diet and activity levels.[23]

Despite the profound impact of diabetes on most communities, this disease has been given limited attention in the health services literature regarding adequacy of diabetes services in the community, measurement of diabetes mortality, hospital utilization and measures by which hospitalization can be reduced.

A major constraint in obtaining this data has been the difficulty in accurately measuring diabetes prevalence. Hence, most population-based studies have relied on death certificate data to measure diabetes mortality. This data is highly flawed as less than 50% of death certificates will mention the presence of co-existing diabetes. Similarly, the few population-based studies of hospital utilization have relied on the presence of a diabetes diagnosis in the hospital discharge abstract to identify each case. Again, even when an admission is principally related to diabetes, 47% of medical and 88% of surgical discharge summaries have been shown to omit diabetes as a diagnostic category.[137]

A large proportion of diabetes related hospitalization may be preventable. Reduction in diabetes hospitalizations has been associated with attendance at diabetes education programs, specialized multi-disciplinary diabetes clinics, the experience of the patient's family physician, and on a macro level, by reduction in the number of available hospital beds.[10,11,13,105,112]

There have been a handful of large scale diabetes surveillance studies in the health services literature. These have been carried out in the United States, Finland, Britain and New Zealand.[138,139,3,111,140,128] Population-based Canadian data is unavailable largely because there is no national diabetes surveillance program; most provinces are only now beginning to collect some of this data and other provinces have no diabetes surveillance.

Data from other parts of the world may not be applicable to the Canadian situation where there is a unique form of universally funded health care, an unprecedented increase in the proportion of those older than age 65 and a large proportion of immigrants and persons of Aboriginal status. The unique meld of the Canadian population, their particular health care environment, and the profound impact of diabetes both on the population and the health care system, is such that population based measures of the adequacy of diabetes care in Canada are sorely needed.

3. Rationale for Population-Based Measurement of Diabetes-related Hospitalization, Complications and Mortality

Review of the literature has indicated that there is limited surveillance data describing diabetes and its complications, and there is a striking paucity of this data in Canada. This lack of data is astounding considering the profound impact of diabetes both on a personal as well as national level. The first aim of this study was therefore to accurately measure the prevalence cohort of persons with diabetes in the province of Manitoba on a population wide basis for the fiscal year 1991-92. As previous studies in other jurisdictions had suggested that diabetes prevalence was inversely proportional to socio-economic status, a secondary goal after measuring diabetes prevalence, was to relate this to measures of socio-economic status in the city of Winnipeg.[103] Documenting this association in Canada is important to help direct diabetes treatment and prevention initiatives, particularly as disadvantaged communities appear to be at higher risk not only for diabetes, but also for its multi-system complications.

Comparing patterns of diabetes hospitalization and mortality to the non-diabetic population is an important goal, as this highlights the public health burden of diabetes. The measurement of hospitalization and mortality is also critical as it has been shown that appropriate delivery of diabetes care in the community will reduce overall hospital utilization. Two early studies demonstrating this positive impact have been followed by a gradual change from hospital-based to community-based treatment in Canada and around the world.[10,11] The ongoing importance of a community based diabetes health care team appears prominently in the latest Canadian Diabetes Association National Treatment

Guideline.[8] Despite the paradigm shift which has occurred in the delivery of diabetes services over the past 20 years, it is surprising that ongoing studies of hospital utilization have not been carried out to assess the effectiveness of this change in services. Measurement of diabetes hospitalization at the present time could thus provide crucial information for formulating health care policy regarding diabetes for the next century and for developing strategies to reduce the burden of this disease.

Part of the explanation for lack of surveillance data regarding diabetes hospitalizations and the effectiveness of community diabetes care, is the difficulty obtaining accurate population-based data and the varied means by which diabetes care is delivered. The lack of a national diabetes initiative may have contributed to the fractured way in which diabetes care is delivered across Canada. The reality of this care is that a person with diabetes living on a reservation in northern Canada may have highly different access to community-based diabetes services compared to someone living in an urban center. Primary diabetes services may be limited to a northern nursing station or to a solo family practice physician or possibly as varied as having access to a highly experienced family doctor utilizing a community or hospital-based diabetes education center, community nurses and nutritionists, hospital-based clinics and periodic referrals to endocrinologists and multiple other specialists. The complexity of diabetes care thus makes profiling diabetes services a difficult task. This further supports the need to measure hospitalizations on a population-wide basis as this is one means by which one can distill the end result of these multiple diabetes services. As the Manitoba Health Database permits identification of one's place of residence, it is thus possible to measure some of the important variables which influence diabetes prevalence and availability of community-based services. This study therefore measured diabetes hospital utilization according to Aboriginal status, health region and urban versus rural residence. This permitted identification of populations at high risk for various diabetes complications. These populations with increased disease burden could then be targeted for improvements in disease prevention and treatment.

Various diabetes complications were chosen based on ease of measurement, and their importance as markers of effective delivery of community-based diabetes care. Acute metabolic complications (hypoglycemia, hyperglycemia) were identified as hospital-based complications sensitive to inadequacies in short term management of diabetes. These also represent highly preventable admissions as demonstrated by the work of Miller and Davidson.[10,11] Hospital admissions sensitive to long-term complications of diabetes were also measured. These included limb loss (a marker of peripheral vascular disease and neuropathy), renal disease (a marker of long term glycemic control), cardiovascular disease and stroke (markers for blood pressure control, lipid management, and smoking prevalence).

Measurement of diabetes hospitalization experience on a population-wide basis permits ongoing recognition of the healthcare burden of diabetes, aids development of health-care policy, identifies high risk groups, and helps develop strategies to reduce the burden of disease. Utilization of the Manitoba Health claims database provides a system whereby one can repetitively evaluate progress in diabetes prevention and management.

4. MATERIALS AND METHODS

4.0 Objectives

This study was designed with four major objectives as follows:

1. To measure diabetes prevalence in Manitoba for the fiscal year 1991-92 and to relate that prevalence to socio-economic status for urban residents (city of Winnipeg).
2. To compare patterns of hospital utilization and mortality between diabetic and non-diabetic populations.
3. To compare the impact of treaty status on patterns of hospital utilization for diabetic and non-diabetic populations.
4. To measure hospital utilization for various diabetes complications and to relate these to urban residence (Winnipeg vs non-Winnipeg), health region and treaty status.

4.1 Conceptual Framework

The conceptual framework for this study is based on the supposition that low hospital utilization represents one bench-mark of effective diabetes management in the community. Previously cited studies have documented that improvement in diabetes services act to reduce hospitalization toward population mean levels, suggesting that a significant proportion of hospitalization is preventable.[10,11,13,14] As there are multiple determinants for diabetes-related hospitalization, this conceptual framework does not assume that hospitalization is solely related to the effectiveness of diabetes health care delivery in the community. However, hospitalization experience in a population does represent one useful measure of burden of illness, information which is drastically needed in Canada at this time.

Surveillance data from the UK and US support the fact that hospital utilization amongst diabetics can vary according to geographic location.[21,48] These geographic variations are as yet unexplained but likely represent a complex interaction between genetic predisposition, environmental influences and health service delivery. An attempt to use clinical and biological characteristics in a multivariate model to predict hospitalization, has demonstrated that these factors only account for a small proportion of variation in hospitalization.[109] The effects of ethnic minority status, poor socioeconomic level and process of care have been implicated as important components of this causal pathway, and may represent more powerful predictors of regional hospital use patterns. Based on these findings, the current study was designed to take into account geographic variation (particularly variations between health regions) as well as access to specialized tertiary care services (Winnipeg vs non-Winnipeg).

Comparison of hospital use between diabetics and non-diabetics is an important analytic approach which contrasts the increased utilization imposed by diabetes against a clear standard. It was felt important to assess these differences during the initial part of the study to obtain an overall measure of excess hospital utilization pertaining to diabetes (particularly as the Canadian Diabetes Association has a stated goal of improving diabetic health status to a level commensurate with the non-diabetic population).[113]

Comparisons between diabetics across regions were examined to determine whether large regional differences in utilization could be identified. Specific outcomes were chosen to supplement total hospital utilization to provide greater detail concerning health status. The impact of Aboriginal status was reviewed within the diabetic population as current data has indicated an increased prevalence of diabetes and its complications in this population.

4.2 Study Design

This study used a cross-sectional design, describing the hospitalization experience of a province-wide cohort of persons diagnosed with diabetes mellitus for the fiscal year 1991-92 in Manitoba. The Manitoba Health database was relied upon as sole data source. This database is comprehensive, in that it records the vast majority of out-patient contacts with physicians, hospital admissions and nursing home occupancy in a province with universal medical coverage.

This database consists primarily of six major files. The hospital file consists of all in-patient and day surgery admissions to acute and chronic care hospitals and includes all surgical procedures and can include up to 16 diagnoses. The medical claims file describes physician contacts in offices and out-patient departments and includes the patient's and physician's identification numbers, the date the service was rendered and the diagnosis. The personal care home file describes admissions and separations for individuals in personal care homes. The registration file describes the total insured population of the province and can identify them by family group, dates of coverage, marital status and place of residence. There is a mortality file describing date and cause of death and a cancer registry describing date of cancer diagnosis and cancer type.

Individuals are anonymously but uniquely identified, permitting linkage across different files. This permits the description of health care episodes from an individual patient perspective; outcomes can therefore be measured both in terms of number of persons affected as well as total number of patient events. Registry and mortality files permit the accurate measurement of population sub-groups, by accounting for emigration, immigration and mortality.

The Manitoba Health database is thus a rich source of information as it identifies the entire population of the province, a consistent set of identifiers permits linkage across files, it contains longitudinal data extending back to 1970 and contains significant diagnostic information. The completeness of this database has been partly promoted by universal health insurance, where premium payment is not required, thus providing coverage for the entire population. Further, the fee for service format of the Canadian Medicare system helps to procure relatively detailed diagnostic information. Despite these benefits however, such a database has, and will continue to require ongoing assessment regarding its validity and reliability.[114] There has been a significant effort over the past 20 years to firmly measure the validity and reliability of this claims database for research purposes.[4-7,115-117] These studies have shown that procedures associated with billable tariffs are accurately recorded and that a comparison of Manitoba Health data with physician's medical records show close correlation with regard to the number of patient contacts.[118-121] Further, diagnoses recorded in hospital medical records appear to correspond closely to hospital claims made in the database.

The study proceeded in three phases. The first phase involved identification of a cohort of individuals with diabetes using a three year profile of claims data for the fiscal years 1990/91 to 1992/93. Identification of this cohort required the use of four files: the hospital file, medical claims file, registration file and mortality file. The second phase involved measuring total hospital utilization in the diabetic cohort through standardized comparison to the non-diabetic population in Manitoba. Direct standardization using age and gender specific rates for the total Manitoba population was used as the standard.

The third phase of the study involved comparisons of hospital utilization within the diabetic population. Comparisons within this population were made using direct standardization for age and gender, using the provincial diabetic population as the standard. This permitted standardized comparisons of hospitalization patterns across Manitoba's health regions and between two aggregate regions (Winnipeg and Non-Winnipeg).

4.3 Study Population

The study population included all persons registered with Manitoba Health during the fiscal year 1991/92 who had received a clinical diagnosis of diabetes at some point between 1990/91 - 1992/93. Diabetics were identified as those persons who had one or more outpatient physician contacts and/or at least one hospital contact in which a diabetes diagnosis had been recorded (ICD-9 CM code 250-250.9, 648.0, 648.8).

Four studies have now documented the utility of the Manitoba Health database to measure diabetes incidence and prevalence.[4-7] The validity of using claims data to define diabetes cases has been assessed by comparison against two criteria: 1) self -reported diabetes in the Manitoba Longitudinal Study on Aging, and 2) registry files for persons enrolled in the Diabetes Education Resource program. A 12 year profile of diabetes diagnoses associated with physician visits and hospital admissions was found to have a sensitivity of 84% and specificity of 96%, where self-reports of diabetes were used as the "gold standard".[4] While 14 individuals with self-reported diabetes had no recorded diagnosis based on claims data, 42 who failed to mention a diabetes diagnosis, had it documented in their hospital record. This has prompted Young et al. to suggest that administrative databases may be a more appropriate gold standard than survey data.

In a second sub-study, a sixteen month profile of medical and hospital files was cross-referenced with 817 confirmed diabetes patients who had enrolled in the Diabetes Education Resource program. Claims data demonstrated a 93% sensitivity at identifying this cohort.[4]

Blanchard et al have now further validated the utility of the Manitoba Health insurance data base to measure the incidence and prevalence of diabetes in Manitoba for the years 1986 to 1991.[6] In this data base they defined a diabetic as any person having at least two separate outpatient physician claims for diabetes within two years of each other or at least one hospital separation record with a diagnosis of diabetes. Prevalent cases were accrued by capturing patients between the years 1986 to 1991; this study identified 47,890 Manitobans greater than age 25 who had diabetes for the year 1991 using this definition.

Prior to identifying the diabetic cohort for this study (fiscal year 1991/92), a sensitivity analysis was carried out. During this process, Manitoba Health physician claims, and hospital separations data (any of 16 diagnoses), for each of three consecutive fiscal years were used to identify diabetic patient contacts within the health care system by breaking these contacts down into persons who had a 1) single out-patient visit, 2) a single hospital separation 3) or greater than one visit or separation during that year.

4.4 Instrumentation

Measurement of hospital utilization for this study was based upon methods used in the Population Health Information System (PHIS) which was developed in Manitoba as a program enabling the linkage of health status to health utilization using claims data. The "Utilization of Hospital Resources Module" as formulated by Black, Roos, and Birchill as part of the PHIS, was utilized as the primary measurement format.[122] Hospital care was attributed to a person's area of residence, so that utilization could be accurately assessed on the basis of health region as well as where hospitalization occurred. Population counts were based on analysis of Manitoba Health Registry data as of December 31, 1991. Hospitalization in the Utilization of Hospital Resources Module was measured using both acute and extended treatment beds, with analysis limited to in-patient and major surgical out-patient cases. This module was based upon 191,906 total hospital contacts for a population of 1,140,406 Manitobans. Registry file information was used to assign region of residence, except for treaty status Indians, where postal code information was used. Rates of service use were calculated using either total diabetic or non-diabetic cohorts as the denominator, except where age or gender specific rates were indicated. Types of rates calculated were described in the Hospital Resource module. Comparisons across health regions and between diabetics and non-diabetics were adjusted using direct standardization as previously described.

The registry file was also used to identify persons of treaty status, who can be identified by their municipality code. As mentioned above, the municipality code would refer to the reserve of origin for the individual identified. As that individual may not be living on the reserve, a postal code was used to assign residence. This methodology has several limitations as it is not updated regularly and thus under counts all persons with treaty status, and particularly woman and children. Also, the Registry would not identify Aboriginal Canadians who had lost treaty status and the substantial proportion of individuals of Metis origin. The registry file identified a total of 59,443 individuals with treaty status of whom 5.9% (3,558) were diabetic. A report by Indian and Northern Affairs Canada reported 73,219 First Nations members in Manitoba in 1997.[136] This report identified a First Nation individual if they were on the Federal Indian Registry.

The Registry used for this study thus under counted those with treaty status, which would tend to under estimate the impact of diabetes in the Aboriginal population.

Socioeconomic status was briefly addressed in this study, by assessing how it correlated with diabetes prevalence. Socioeconomic status was measured using the procedure outlined by Mustard.[123] This procedure incorporates census data which documents household income based on enumeration areas. Enumeration areas were grouped from poorest to wealthiest and then into five population quintiles each containing 20% of the population. Each case was linked to an enumeration area by postal code. Those not linked to an enumeration area had an imputed medium quintile rank. This methodology was utilized for Winnipeg residents only, as there is reduced reliability using this methodology for non-urban centers.

The relevant ICD-9-CM codes for diabetes complications are outlined in Appendix A. Previous studies have demonstrated that the validity of a medical diagnosis in a claims database is increased significantly by using broad definitions, where the correct principal diagnosis was recorded in at least 90% of cases.[124,125] Based on this data, extremely broad and far reaching definitions for various procedures and diagnoses were used utilizing as many pertinent ICD-9 codes as possible. To give clarity to this, certain specific conditions of great importance, (ex. acute myocardial infarction vs all cardiovascular diseases) likely to be recorded accurately, were also analyzed.

4.5 Criteria for Choice of Diabetes Related Health Outcomes

The choice of health outcome measurement as it pertains to diabetes and the need to better define and measure these outcomes has recently been reviewed.[21] The criteria for choosing a health service outcome indicator are outlined in Table 2. The first of these criteria involves identifying outcome indicators which are clearly related to the goals of one's health care program. However, it has only been since 1992 that goals and clinical practice guidelines for diabetes care have been clearly delineated in Canada.[113] The goals established in that document are presented in Table 3. While these goals are laudable they lack specificity and cannot clearly be related to outcome assessment. Program goals for the delivery of diabetes care in the UK are shown in Table 4, and in contrast to Canadian goals, contain the necessary specificity to enable a clear link to outcome assessment.[21] These goals differ, in that the former described concepts such as quality of life, self-care and long term complications. The latter describe more specific and measurable end points: examples of these include blindness or amputation.[126]

In choosing an outcome it is also important that it be given a clear operational definition. Peripheral neuropathy is a construct which requires a specific definition before it can be measured and that measurement understood. Sensory neuropathy maybe operationalized by assessing the response to a standardized sensory test using a Semmes-

TABLE 2

CRITERIA FOR HEALTH SERVICES OUTCOME INDICATORS

---

1. COMMENSURATE WITH PROGRAM GOALS
2. CLEARLY DEFINED
3. MODIFIABLE THROUGH TREATMENT OR PREVENTION
4. OUTCOME HAS DELETERIOUS CONSEQUENCES FOR PERSON AFFECTED
5. FREQUENT
6. MEASUREMENT RELIABILITY
7. MEASUREMENT VALIDITY
8. MEASUREMENT IS COST EFFECTIVE
9. MEASUREMENT IS NON-TIME CONSUMING
10. FLEXIBILITY-(OUTCOME CAN BE ASSESSED WITH NUMEROUS DATA SOURCES AND METHODOLOGIES)

Reference 21

TABLE 3

CANADIAN DIABETES CARE OBJECTIVES

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1. To relieve symptoms
2. To prevent and treat acute and long term complications
3. To promote self-care where appropriate
4. To treat accompanying disorders
5. To improve the quality of the patient's life
6. To reduce morbidity and mortality associated with diabetes

Reference 113

TABLE 4

OBJECTIVES OF A DIABETES CARE PROGRAM (UNITED KINGDOM)

---

1. To identify all those with diabetes
2. To involve all those identified in an appropriate program of care
3. To ensure recipients of program have access to diabetes education
4. To eliminate emergency admissions for hypo- or hyperglycemic coma
5. To eliminate blindness and visual impairment from diabetic retinopathy
6. To reduce foot ulceration and limb amputation
7. To identify diabetic nephropathy in it s early stages and reduce ESRD
8. To reduce premature mortality due to macrovascular complications
9. To eliminate fetal wastage in diabetic pregnancy
10. To eliminate congenital malformations in the offspring of diabetic mothers

Reference 21

-Weinstein monofilament for example, or by measuring amputation if one were using a database.

It would be inappropriate to measure outcome indicators which were not preventable or subject to modification. In this situation, a diabetes services program could not be expected to influence outcome. It is also important to measure outcomes which are significant. While diabetes effects every organ system, there are some outcomes which are quite minor in comparison to others.

The frequency of an outcome variable is also an important consideration, as making an impact on common outcomes tends to have more wide-spread benefit to patients. Outcome frequency should not be overstated however, as an uncommon severe outcome such as congenital malformation is no less important than cardiovascular outcomes which influence many more patients.

Most of the foregone criteria describe essential elements of any outcome variable and are largely independent of study design. Several important criteria also exist which directly influence study design and measurement. Reliability and validity of outcome measurement are two important criteria which can influence design issues such as data source. Reliability is concerned with the degree of consistency associated with repeated measurement and is an indicator of random error. Reduction in random error is of great importance in that it improves the sensitivity by which the influence of interventions on outcome can be measured. The reliability of a measurement of visual acuity in diabetes could be assessed, for example, by having another individual repeat the measurement on a subset of study patients. Reliability may be easily measured in a prospective study or possibly with a clinical database. The reliability of some outcomes (ex. visual acuity measurement), cannot be carried out easily with an administrative database as the data source.

Validity assesses how closely an instrument measures the outcome it is intended to measure. For example, does a database amputation tariff truly measure leg amputation or does it in fact represent resection of a digit or a completely separate procedure? Optimally, outcomes should be validated by some alternate mechanism such as chart review (criterion validity).

Additional criteria for an ideal outcome indicant include the ease with which it can be measured, which translates into savings in terms of time and money. Flexibility is also important. Ideally, an outcome indicator would be accessible through both primary and secondary data collection procedures for example.

Diabetes outcomes may be classified according to numerous complex schemata, since these variables may represent initiating factors ex. (body mass index), indicants of metabolic control ex. (glycosylated hemoglobin), qualitative measures ex. (satisfaction), short-term/intermediate complications ex. (microalbuminuria), and long term sequelae ex. (amputation). The Centers for Disease Control community based diabetes control program in the United States has attempted to simplify this complex amalgamation of outcomes by recommending four sentinel program indicators - retinopathy, adverse outcomes of diabetic pregnancy, amputation and hypertension.[1] These indicators were chosen based on evidence supporting their preventability and the feasibility of data collection on a population-based level. An alternative scheme is presented in Tables 3 and 4, where outcome variables are temporally categorized as short-term/intermediate and long-term outcomes. The choice of outcome indicators should be based on how well it reflects the ideal criteria previously set for it. Because some of these criteria are highly design dependent, the method of data collection is intimately associated with the appropriateness of any outcome variable.

Data collection methods may be classified in a highly simplified format as original, (collected with the express purpose of subsequent analysis) such as survey research or clinical trials versus pre-collected data (chart review, administrative data sets, clinical practice data sets). Each of these has it owns respective advantages and disadvantages as outlined in Table 5, and may therefore compliment one another in terms of study findings.

Outcome indicators for this study were chosen based on the ability of the Manitoba Health database to adequately identify these outcomes. Administrative databases tend to be poor at measuring short-term and intermediate diabetes outcomes in a valid fashion. Therefore, outcomes such as blood pressure control, dyslipidemia, glycemic control, microalbumin excretion, early retinal injury, neuropathy and obesity cannot be measured with this system. Of these short-term and intermediate outcome variables, the one best measured through an administrative database is acute metabolic decompensations which have clear ICD-9 codes.

Administrative databases are better suited to measuring long-term outcome variables. While this database would be inappropriate for measuring neuropathy or early vascular disease, it is well suited for measuring the end result of these pathologies by measuring amputation, which has a definable ICD-9 code. There are also clear codes for peripheral vascular reconstruction and for identifying acute coronary syndromes and coronary procedures, which again permit ready measurement through the Manitoba

TABLE 5

ADVANTAGES OF ALTERNATE DATA COLLECTION METHODS

Criterion	Administrative Data	Clinical Practice Data Set	Original Data Collection
RELIABILITY	+/-	+	++
VALIDITY	+/-	+	++
DESIGN FLEXIBILITY	+/-	+	++
LONGITUDINALITY	++	+	++
GENERALIZABILITY	++	+	+/-
AFFORDIBILITY	++	+	+/-
TIME SAVINGS	++	+	+/-

Health administrative database. Microvascular complications such as retinopathy and nephropathy are difficult to measure in early stages, but late measures of their impact on a population can be documented by measuring hospital admissions for end-stage renal disease and dialysis or complex retinal surgeries. The Manitoba Health database is well suited to the measurement of premature mortality (0-64 years) and this was chosen as a global outcome marker of the adverse influence of diabetes on health status.

5. RESULTS

5.0 Sensitivity Analysis for Definition of Diabetic Cohort

Analysis of physician outpatient claims and hospital separations for diabetes revealed that for any given year, approximately 68% of persons with diabetes had greater than one contact with the system in the form of out-patient and/or hospital contacts. (Table 6) The positive predictive value for these different types of contacts was then assessed by determining whether at least one other contact occurred with the system sometime during the three year period of 1990/91 to 1992/93. The results indicated that if someone had more than one visit during a single fiscal year that there was on average a 90% chance of having had another contact during the three year period. Cumulative diabetes cases over the three year period were used to arrive at a diabetes prevalence cohort for the fiscal year 1991/92 by incorporating data from all three years after adjustment for immigration, emigration and mortality. (Figure 1). A total of 45,117 persons with diabetes were identified using the least restrictive diagnostic criterion (i.e. having any documented contact with the system as a diagnosed diabetic during the three year period). Restricting the definition to only persons who had two or more contacts reduced the sensitivity by 24%, to a population of 34,331. Restricting this further to only persons having two or more contacts for the year in question reduced the prevalent cohort to a population of 22,041. The least restrictive diabetic cohort definition was used, as the majority of persons with one contact have been shown to have had former or subsequent contacts with the system.[6] Furthermore, relative diabetic versus non-diabetic hospitalization rates using these various definitions did not show any significant

Fig.1 MANITOBA DIABETES PREVALENCE SENSITIVITY ANALYSIS

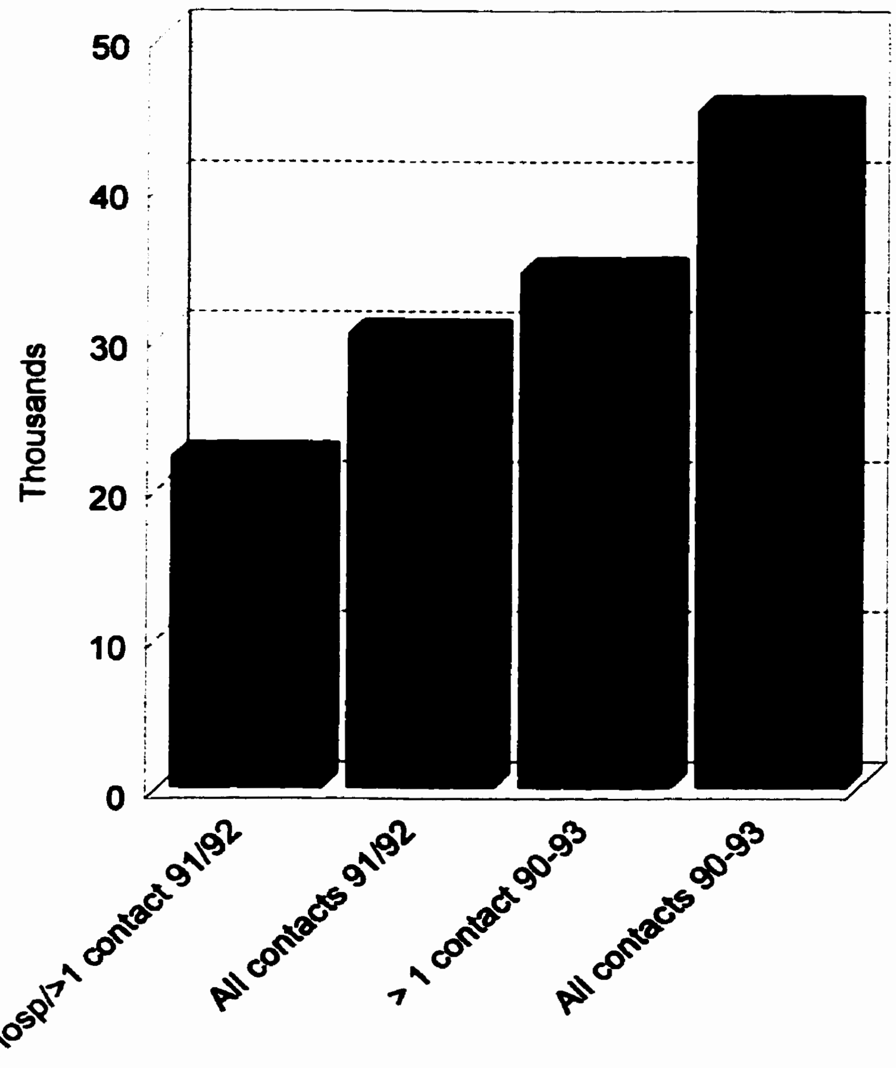


TABLE 6

PREDICTIVE VALUE OF A SINGLE DIABETES DIAGNOSIS
(Confirmation based on identification of one or more diabetes cases 90/91-92/93)

CATEGORY	TOTAL	>=1 CONTACT 90/91-92/93	POSITIVE PREDICTIVE VALUE
1990/91			
1 physician visit	7650	4377	57%
1 hospital separation	424	284	67%
>1 contact	18517	17045	92%
TOTAL	26591	21706	82%
1991/92			
1 physician visit	8196	4639	57%
1 hospital separation	1367	795	58%
>1 contact	20674	19130	93%
TOTAL	30237	24564	81%
1992/93			
1 physician visit	8486	4530	53%
1 hospital separation	1522	882	58%
>1 contact	20858	17467	84%
TOTAL	30866	22879	74%

differences between diabetic cohorts. The least restrictive definition was associated with lower rates of hospitalization compared to restrictive definitions, which tended to select for persons with more system contacts and possibly poorer health status. The figure 45,117 represents 4.1% of the total population for Manitoba in that year and correlates well with the data of Young and Blanchard.[4-7]

5.0.0 Socioeconomic Status and Diabetes Prevalence

Prior studies have suggested the presence of a correlation between socioeconomic status and diabetes prevalence, and prompted use of methodology to explore this possible association.

This relationship was initially examined by reviewing the crude prevalence of diabetes by Winnipeg region, as these regions have been previously characterized according to socioeconomic status (Fig. 2).[123] This analysis revealed that diabetes prevalence in regions associated with high socioeconomic status (Winnipeg south-east and south-west) was less than 3% and this prevalence gradually increased for regions of decreasing status, with the highest being the inner-core region, with a prevalence of just under 5%. The Winnipeg population was then aggregated into five socioeconomic quintiles as described by Mustard, and this again revealed an identical pattern, with diabetes prevalence in the lowest socioeconomic quintile approximately twice that of the highest (Fig. 3). Repeating this analysis using three different diabetic cohorts (defined previously) revealed that this association between socioeconomic status and diabetes prevalence remained consistent, even for diabetes definitions which were highly conservative, likely representing close to 100% sensitivity for that diagnosis. To assess the influence of treaty status, the analysis was repeated by excluding all persons with

Fig.2 Crude Prevalence of Diabetes by Winnipeg Region 1991/92

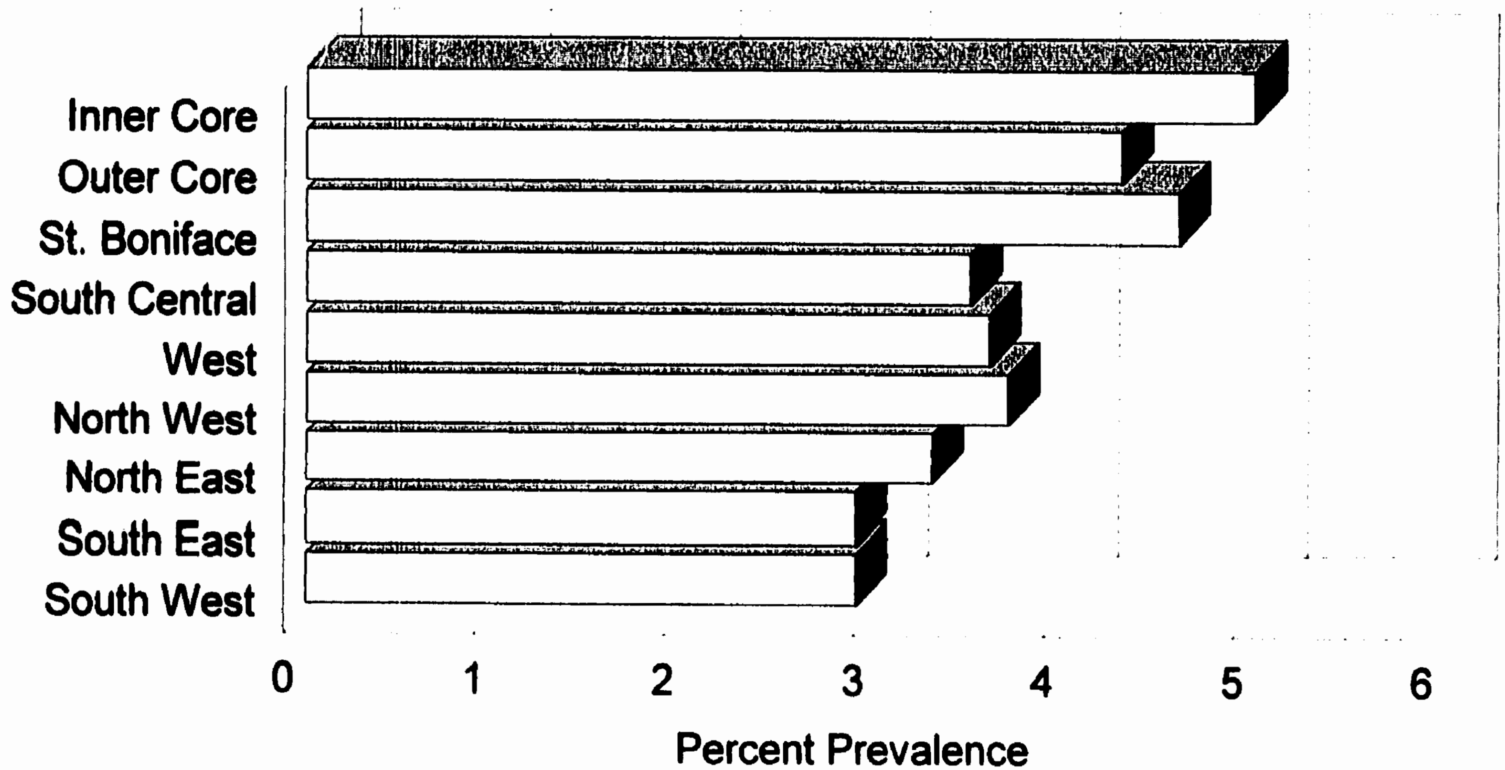
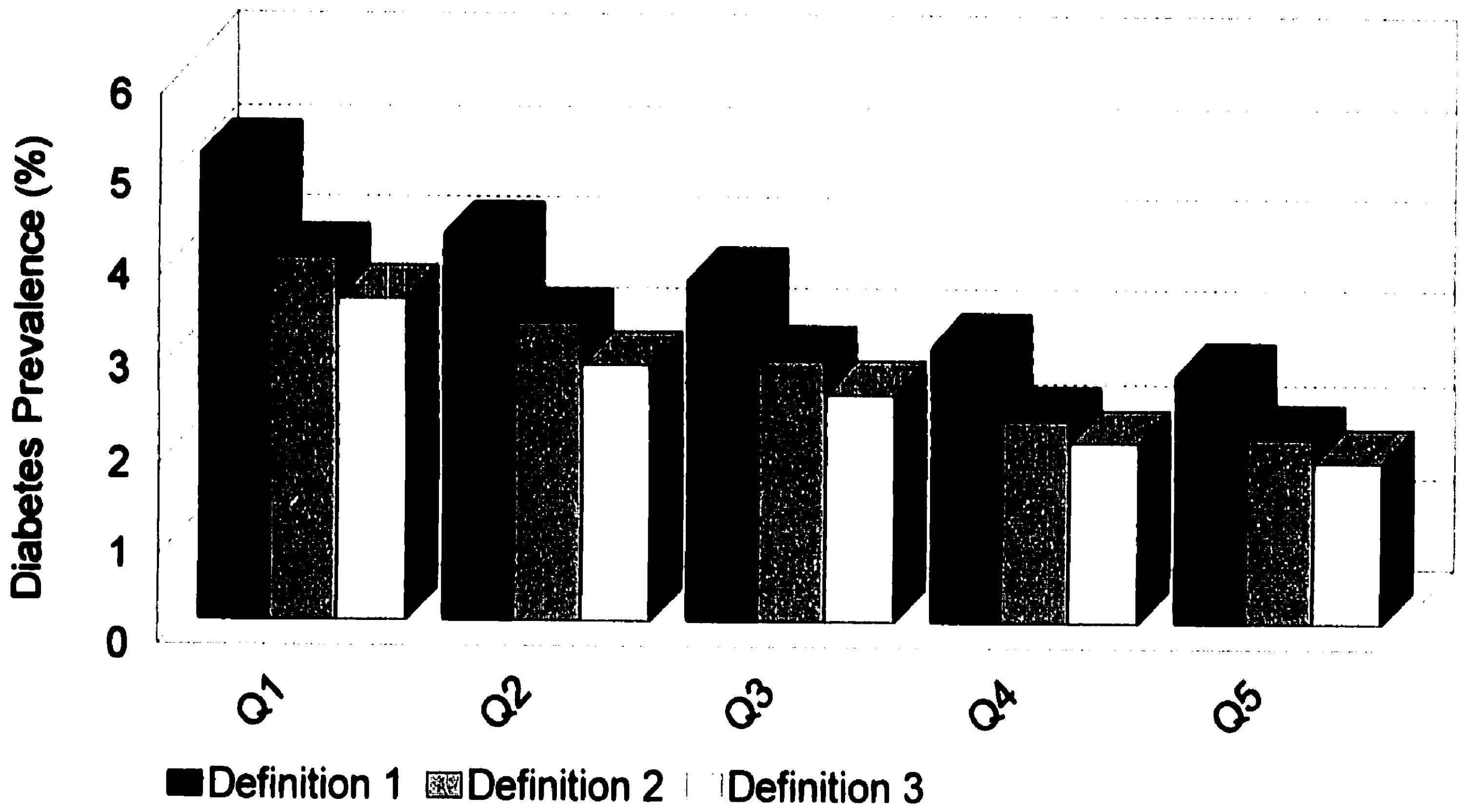


Fig.3 Winnipeg Diabetes Prevalence 91/92
By Socioeconomic Quintile



treaty status designation. Following this manipulation, prevalence rates for diabetes remained consistently associated with socioeconomic quintile.

5.1 Patterns of Hospital Utilization and Mortality Between Diabetic and Non-Diabetic Populations

5.1.0 Use of All Hospital Care

A total of 191,906 hospital separations were identified for fiscal year 1991/92, of which 147,633 separations represented short in-patient hospital stays (60 days or less), a further 3,620 separations represented long-stay admissions (60 days or more) and 40,653 represented day surgery patients who were not admitted. Diabetic separations numbered 20,496, of which 17,626 were short stay, 654 long stay and 2,216 were for day surgery. The diabetic cohort, representing less then 5% of the total population, accounted for over 10% of hospital use.

The adjusted rates of use of all hospital care (short and long stay, day surgery), comparing diabetics to non-diabetics are shown in Table 7. This analysis revealed that diabetics were almost twice as likely to experience a hospital contact. As hospital re-admissions were increased three fold between diabetics and non-diabetics, the rate of hospital separations was over twice that of non-diabetics. For inpatient admissions (i.e. excluding day surgery), the average length of stay was 60% longer in the diabetic population. A higher hospital separation rate and length of stay resulted in twice the overall use of hospital days for the diabetic population.

TABLE 7

RATES OF USE OF HOSPITAL CARE

FOR DIABETIC AND NON-DIABETIC MANITOBANS

1991-92

	DIABETIC	NON-DIABETIC	RATIO (95% Confidence Interval)
Persons Hospitalized per 1000 Residents	225.4	122.0	1.8 (1.78-1.92)
Hospital Separations per 1000 Residents	343.4	160.4	2.1 (2.07-2.17)
Hospital Readmissions per 1000 Residents	118.0	38.4	3.1 (2.01-4.13)
Average Length of Stay (days)	13.1	8.0	1.6 (NA)
Hospital Days per 1000 Residents	2807.2	1337.0	2.1 (2.08-2.12)

5.1.1 Use of Short versus Long Stay Care

Analysis of rates of hospital care by length of stay (Table 8) revealed that diabetics had over twice the bed utilization compared to non-diabetics for short-term stay (less than 60 days). This finding was present for all length of stay parameters, whether for admissions of less than one week in duration or for lengths of stay of 3 to 8 weeks. Although the use of hospital days for long-stay patients was still 60% greater for diabetics, the impact of diabetes on hospital days was relatively less for long-stay patients compared to short-stay. Differences between short and long-stay in-patient care are further detailed in Table 9 which again documents that hospital separations and use of hospital days are increased in diabetics both for long and short-stays, but this increased utilization is relatively more prominent for short-stay in-patient care. Although diabetic separations were approximately twice that of the non-diabetic population for long-stay care, their length of stay was about the same or lower. This contrasts with short-stay in-patient care where length of stay was 40% greater in the diabetic population.

5.1.2 Patterns of differential utilization of short-stay in-patient care

As the impact of diabetes on hospital utilization was relatively greater for short-stay in-patient care, patterns of differential utilization for short stay care were analyzed further. Differential utilization by level of care (Table 10) revealed a two fold or greater use of hospital days by diabetics by all different types of hospitals. There was less use of urban community hospitals in the diabetic cohort in favor of teaching hospital utilization, increasing the differential use of specialized tertiary services by diabetics by almost three fold compared to non-diabetics. This excess use of specialized tertiary services by diabetics could be expected based on an increase in complexity of care for these patients.

TABLE 8

TOTAL NUMBER OF HOSPITAL DAYS PER 1000

BY LENGTH OF STAY FOR DIABETIC AND NON-DIABETIC

HOSPITALIZATIONS IN MANITOBA

1991-92

Length of Stay (Days)	Diabetic Hospital Days per 1000 (column %)	Non-Diabetic Hospital Days per 1000 (column %)	Ratio
1-8	790.8(28)	321.3(24)	2.5
9-14	348.1(12)	144.8(11)	2.4
15-22	266.0(10)	111.7(8)	2.4
23-59	516.1(18)	214.7(16)	2.4
60+	886.3(32)	544.4(41)	1.6
TOTAL	2807.2(100)	1337.0(100)	2.1

TABLE 9

RATES OF USE OF INPATIENT SHORT STAY
VERSUS LONG STAY CARE FOR MANITOBA
DIABETICS AND NON-DIABETICS

1991-92

	LONG STAY INPATIENT CARE (60+ DAYS)			SHORT STAY INPATIENT CARE (<60 DAYS)		
	DIABETIC	NON-DIABETIC	RATIO	DIABETIC	NON-DIABETIC	RATIO
Persons Hospitalized per 1000 Residents	5.3	2.8	1.9	182.6	86.3	2.1
Hospital Separations per 1000 Residents	5.5	3.0	1.9	296.7	121.9	2.4
Hospital Readmissions per 1000 Residents	0.3	0.1	3.0	114.1	35.6	3.2
Average Length of Stay	173.5	184.6	0.9	8.8	6.3	1.4
Hospital Days per 1000 Residents	886.3	544.4	1.6	1920.9	792.6	2.4

TABLE 10

LEVEL OF HOSPITAL CARE FOR DIABETIC AND NON-DIABETIC MANITOBANS

(NUMBER OF DAYS OF CARE PER 1000 RESIDENTS)

LEVEL OF CARE	DIABETIC	NON-DIABETIC	RATIO
Teaching Hospital	712.6(37)	257.3(33)	2.8
Urban Community Hospital	528.1(28)	262.9(33)	2.0
Major Rural Hospital	294.7(15)	109.6(14)	2.7
Other	385.5(20)	162.7(20)	2.4
TOTAL	1920.9	792.6	2.4

However, when stratifying hospital utilization according to level of complexity (level of co-morbidity and complications weighted as per Refined Diagnosis Related Group program), excess utilization of hospital days remained at least two fold that of the non-diabetic population across all categories (Table 11). This excess utilization was most apparent for admissions of moderate complexity, where persons with diabetes had an almost four fold increase in hospital days.

Similarly, when stratifying the analysis by the relative intensity of resource use, a greater than two fold excess of hospital utilization remained for diabetics for all levels of resource intensity (Table 12).

The type of care received also did not appear to greatly influence the excess use of hospital days by diabetics, as again at least a two fold or greater rate of differential utilization was noted across all categories of care in the diabetic population (Table 13). This was particularly true for adult medical and obstetrical admissions, where the relative increase in diabetic care was increased 2.7 times.

As medical admissions are subject to greater variability in admission rates, possibly reflecting the subjective discretion of the admitting physician, hospital use was also analyzed while stratifying by discretionary nature of admission (Table 14). This did reveal that the differential excess utilization by diabetics was most apparent for high variation medical admissions but a significant two fold excess in hospital days persisted even for low variation and surgical admissions where there would be far less variability in the decision to admit.

TABLE 11

LEVEL OF COMORBIDITY AND COMPLICATIONS FOR HOSPITALIZED DIABETIC AND NON-DIABETIC MANITOBANS

HOSPITAL DAYS PER 1000

LEVEL OF COMORBIDITY	DIABETIC	NON-DIABETIC	RATIO
LOW	898.6(47)	468.6(59)	1.9
MODERATE	694.8(36)	189.5(24)	3.7
HIGH	327.5(17)	134.5(17)	2.4
TOTAL	1920.9(100)	792.6(100)	2.4

TABLE 12

INTENSITY OF CARE FOR HOSPITALIZED DIABETIC AND NON-DIABETIC MANITOBANS

HOSPITAL DAYS PER 1000

	DIABETIC	NON-DIABETIC	RATIO
Very Low	202.9(11)	89.7(11)	2.3
Intermediate	1517.9(79)	610.0(77)	2.5
Very High	200.2(10)	92.9(12)	2.2
TOTAL	1920.9(100)	792.6(100)	2.4

TABLE 13

TYPE OF STAY FOR HOSPITALIZED DIABETIC AND NON-DIABETIC MANITOBANS

HOSPITAL DAYS PER 1000

	DIABETIC	NON-DIABETIC	RATIO
ADULT SURGICAL	454.5(24)	230.0(29)	2.0
ADULT MEDICAL	1057.8(55)	387.1(49)	2.7
OBSTETRICAL	187.9(10)	69.2(9)	2.7
PSYCHIATRIC	101.4(5)	53.5(7)	1.9
PEDIATRIC	119.3(6)	52.7(7)	2.3
TOTAL	1920.9(100)	792.6(100)	2.4

TABLE 14

DISCRETIONARY NATURE OF ADMISSION FOR HOSPITALIZED DIABETIC AND NON-DIABETIC MANITOBANS

HOSPITAL DAYS PER 1000

	DIABETIC	NON-DIABETIC	RATIO
High Variation Medical	1206.4(63)	450.4(57)	2.7
Surgical	445.0(23)	218.1(28)	2.0
Low Variation	136.2(7)	73.3(9)	1.9
Obstetric	133.4(7)	50.8(6)	2.6
TOTAL	1920.9(100)	792.6(100)	2.4

5.1.3 Short Stay In-Patient Care by Non-Winnipeg and Winnipeg Residents

Analysis of hospital utilization by regions (Table 15) again demonstrated a greater than two fold excess in hospital utilization for diabetics both within and outside of Winnipeg. Winnipeg diabetics had the longest length of hospital stay at 10 days versus 8 days for diabetics outside Winnipeg. The total use of hospital days was greatest for non-Winnipeg regions. This was related to the high separation rate for patients outside Winnipeg, which was increased by 40% regardless of diabetic status, consistent with earlier findings.[122]

5.1.4 Relative Risk for Disease Specific Admissions by Diabetic Status

Standardized admission rates were used to derive the relative risk for hospital admission for 11 different diabetes-related outcomes (Fig. 4). The complication with the greatest risk of admission, extremity amputation, had a relative risk of 12.5, (diabetics are 12.5 times as likely to be hospitalized for amputation when compared to non-diabetics). Similarly high relative risks were noted for microvascular disease (retinopathy and renal disease) where the rate of admission was increased ten fold. Foot infection and peripheral vascular disease were 7 to 9 times as frequent as admitting diagnoses for diabetic persons, an expected finding as these are major risk factors for amputation. A two fold increase in pneumonia admissions was noteworthy. The risk of acute MI and stroke demonstrated a greater than two fold increase in the diabetic cohort.

Readmission rates by diagnostic category were also evaluated and this revealed a marked excess in relative readmission for diabetics for diagnostic categories related to

Fig.4 Standardized Relative Risk For Hospital Admission in Manitoba (1991/92) For Persons With And Without Diabetes

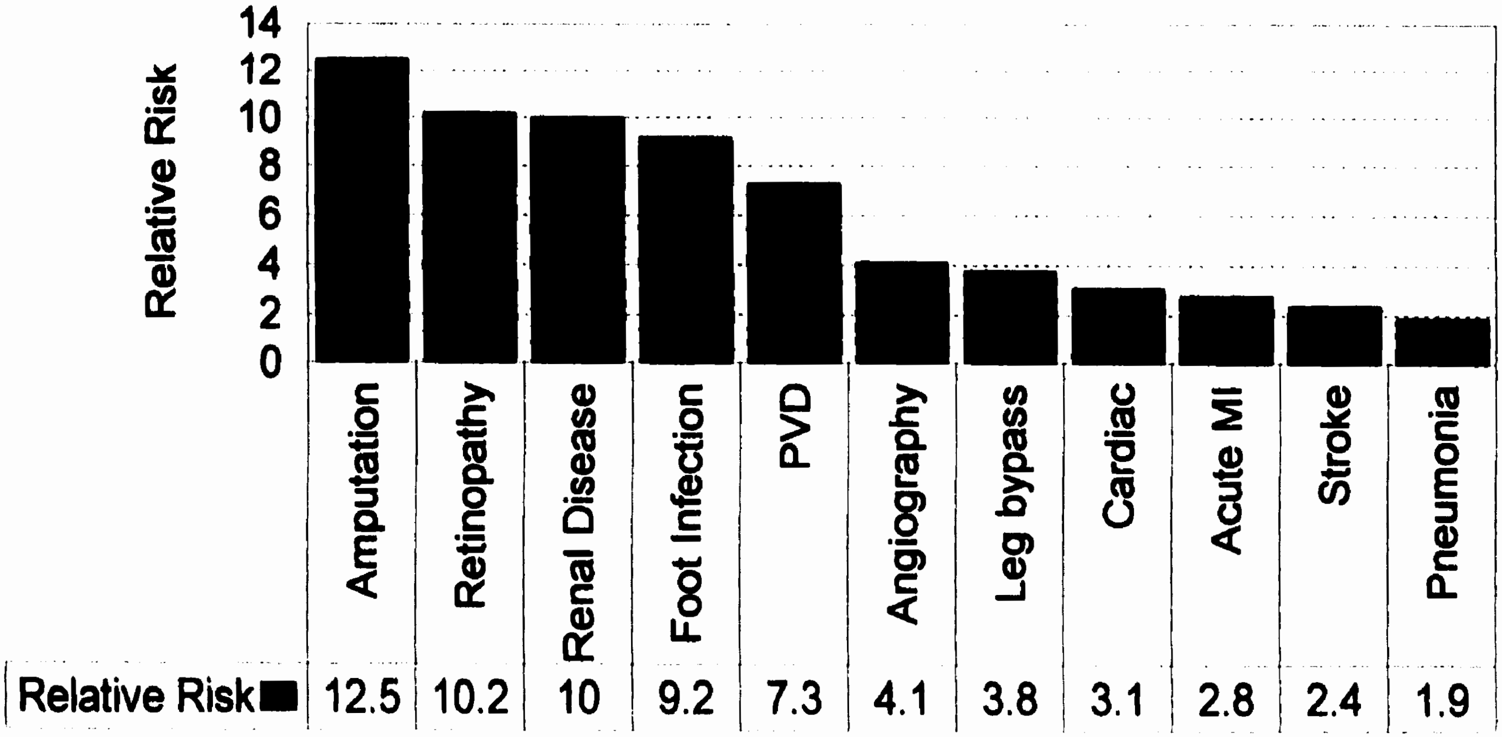


TABLE 15

MANITOBA DIABETES HOSPITALIZATIONS BY REGION

	WINNIPEG			NON-WINNIPEG		
	DIABETIC	NON-DIABETIC	RATIO	DIABETIC	NON-DIABETIC	RATIO
Persons Hospitalized/1000	168.8	79.8	2.1	259.1	118.7	2.2
Separations/1000	226.4	95.8	2.4	373.9	156.7	2.4
Readmissions/1000	57.6	16.0	3.6	114.8	38.0	3.0
Average Length of Stay(days)	10.0	6.9	1.4	8.0	5.8	1.4
Hospital Days/1000	1618.5	687.5	2.3	2259.7	929.7	2.4

(Day surgery and long-stay care excluded)

TABLE 16

STANDARDIZED RELATIVE RISK OF DIABETES HOSPITAL ADMISSIONS FOR CONDITIONS LISTED AS PRIMARY DIAGNOSIS (MANITOBA 1991-92)

COMPLICATION	DIABETIC (ADMISSIONS/1000)	NON-DIABETIC (ADMISSIONS/1000)	RELATIVE RISK	95% CONFIDENCE LIMITS
Amputation	1.88	0.15	12.5	(9.6-16.5)
Retinopathy	3.38	0.33	10.2	(8.5-12.5)
Renal Disease	4.58	0.46	10.0	(8.5-11.8)
Foot Infection	2.94	0.32	9.2	(7.5-11.3)
Peripheral Vascular Disease	3.29	0.45	7.3	(6.0-8.8)
Cardiac	21.29	6.98	3.1	(2.9-3.3)
Angiography	1.99	0.48	4.1	(3.3-5.2)
Leg Bypass	1.37	0.36	3.8	(2.9-5.0)
Pneumonia	6.35	3.30	1.9	(1.7-2.2)
Acute MI	4.50	1.63	2.8	(2.4-3.3)
Stroke	5.08	2.09	2.4	(2.1-2.8)

peripheral complications (amputation, peripheral angiography and peripheral vascular disease), attesting to the recurrence and chronicity of these problems (Fig. 5).

The impact of residence on relative disease specific admissions for diabetics (Table 17) and non-diabetics were compared for Winnipeg and non-Winnipeg regions. This revealed that the ratio of diabetic versus non-diabetic disease specific admissions were significantly greater in Winnipeg for amputation, foot infection, leg bypass and retinopathy. The high Winnipeg ratio of diabetic to non-diabetic admissions for extremity complications and retinopathy may be related to the fact that there is reduced ascertainment of diabetics related to variation in coding for persons outside Winnipeg. The undercounting of diabetics in Non-Winnipeg regions would artificially increase hospitalization rates in the non-diabetic population. This is suggested by the higher than expected rates of amputation and foot infection for non-diabetics outside Winnipeg.

The excess risk of hospitalization for stroke for diabetics living outside Winnipeg was also noted by its prominence.

Table 18 outlines relative hospital utilization between diabetics and non-diabetics, for diagnoses listed as the most responsible diagnosis.

5.1.5 Age-Gender Specific Mortality Rates

Analysis of age-gender specific mortality revealed the presence of a profound excess mortality imposed by a diagnosis of diabetes (Figures 6 and 7). This excess mortality became apparent by the third decade of life and was most prominent for the 25 to 44 and 45 - 54 year age groups, where diabetes mortality was over twice that of the non-diabetic population. This excess mortality became less prominent with increasing age and was no longer a factor after age 75. This data also revealed that the survival

Fig.5 Manitoba Diabetes Hospitalizations 91/92
Readmission Rates by Diagnostic Category

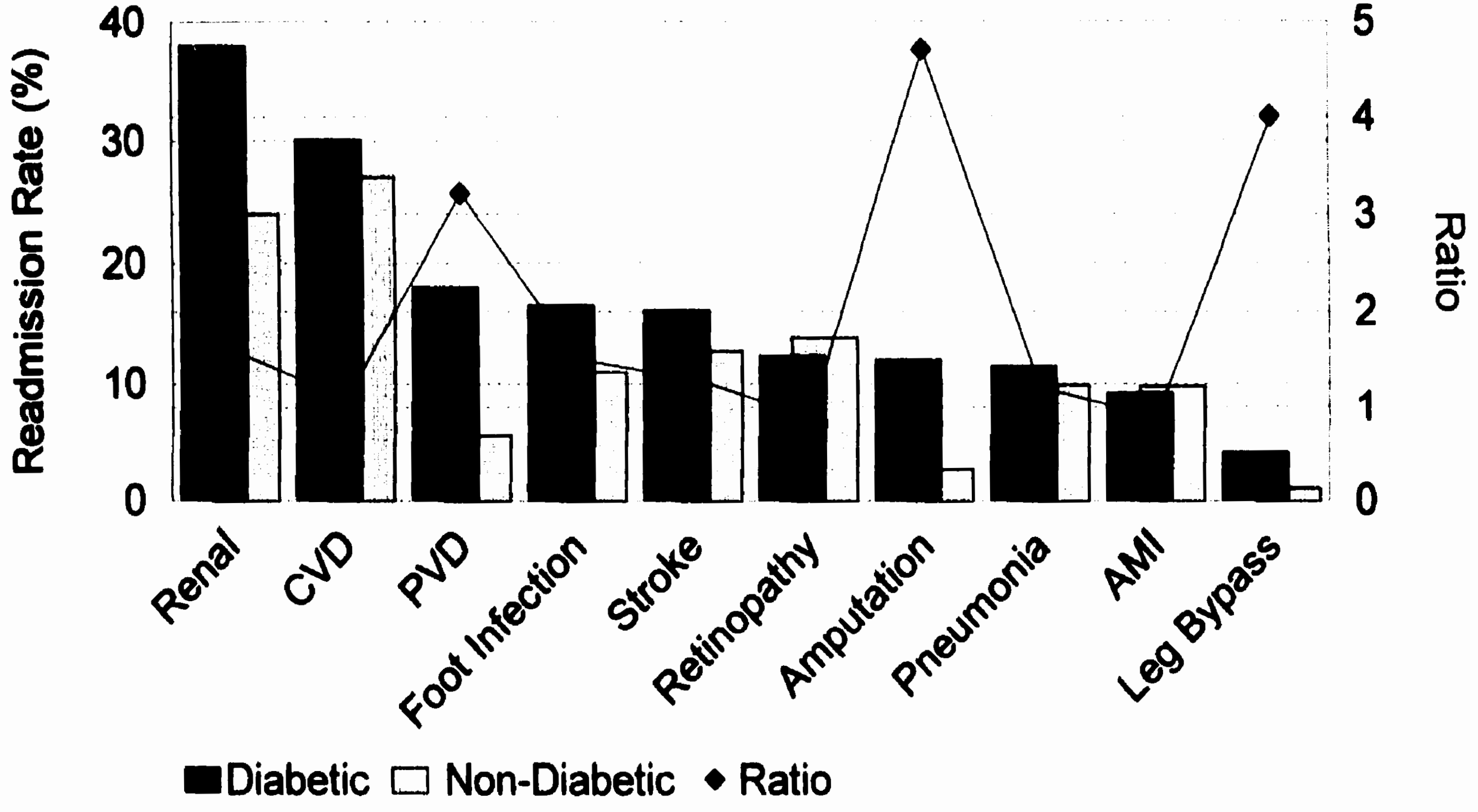


TABLE 17

DIABETIC/NON-DIABETIC HOSPITAL UTILIZATION

(HOSPITAL DAYS/1000) ACCORDING TO REGION

Complication (When listed as primary diagnosis)	Diabetic Winnipeg	Non-diabetic Winnipeg	Ratio	Diabetic Non-Winnipeg	Non-diabetic Non-Winnipeg	Ratio
Amputation	19.2	1.0	18.4	18.6	2.9	6.5
Retinopathy	25.7	1.3	20.0	13.9	1.1	12.6
Renal	43.4	7.4	6.0	49.1	8.0	6.1
Foot infection	42.5	2.9	14.5	60.7	7.3	8.3
PVD	110.9	10.0	11.1	88.7	6.8	13.1
Angiography	54.1	4.6	11.7	28.9	2.1	13.8
Leg bypass	25.1	7.5	6.9	31.5	6.0	5.2
Acute MI	49.6	17.4	2.8	45.1	16.8	2.7
Stroke	124.8	68.9	1.8	192.1	71.5	2.7
Pneumonia	41.1	21.6	1.9	56.4	48.2	1.2

TABLE 18

MANITOBA DIABETES HOSPITALIZATION 1991/92

STANDARDIZED COMPARISON TO NON-DIABETICS BY PRIMARY DIAGNOSTIC CATEGORY

Diagnosis	# of Admissions	Separations per 1000	Average LOS	Hospital Days per 1000	Percent readmission
Foot Infection					
Diabetic	271	2.9	21.5	51.2	19.0
Non-Diabetic	333	0.3	14.6	4.8	12.5
PVD					
Diabetic	353	3.3	35.8	100.8	18.5
Non-Diabetic	447	0.4	19.0	8.6	6.6
Angiography					
Diabetic	223	2.0	41.3	77.8	8.5
Non-diabetic	488	0.5	19.7	9.5	2.1
Limb Bypass					
Diabetic	165	1.4	33.3	42.7	4.4
Non-Diabetic	360	0.4	19.0	6.9	2.8
Amputation					
Diabetic	195	1.9	66.5	103.4	12.8
Non-Diabetic	156	0.1	41.4	6.5	0.0
Cardiac					
Diabetic	2572	21.3	12.2	242.3	31.0
Non-Diabetic	6974	7.0	11.1	77.7	27.4
Acute MI					
Diabetic	528	4.5	11.3	47.8	9.1
Non-Diabetic	1634	1.6	10.6	17.3	9.8
Renal					
Diabetic	332	4.6	13.6	46.0	39.3
Non-Diabetic	479	0.5	16.4	7.8	23.9
Retinopathy					
Diabetic	152	3.4	5.7	19.8	12.7
Non-Diabetic	339	0.3	3.7	1.2	15.1
Pneumonia					
Diabetic	476	6.3	10.0	49.0	13.5
Non-Diabetic	3488	3.3	9.7	33.0	10.9
Metabolic					
Diabetic	519	23.1	13.5	6.2	18.2
Non-Diabetic	16	0.01	6.3	0.1	0.0
Stroke					
Diabetic	657	5.1	32.9	154.8	16.9
Non-Diabetic	2081	2.1	33.0	69.4	13.4

Fig.6 MALE AGE-SPECIFIC MORTALITY RATES
MANITOBA

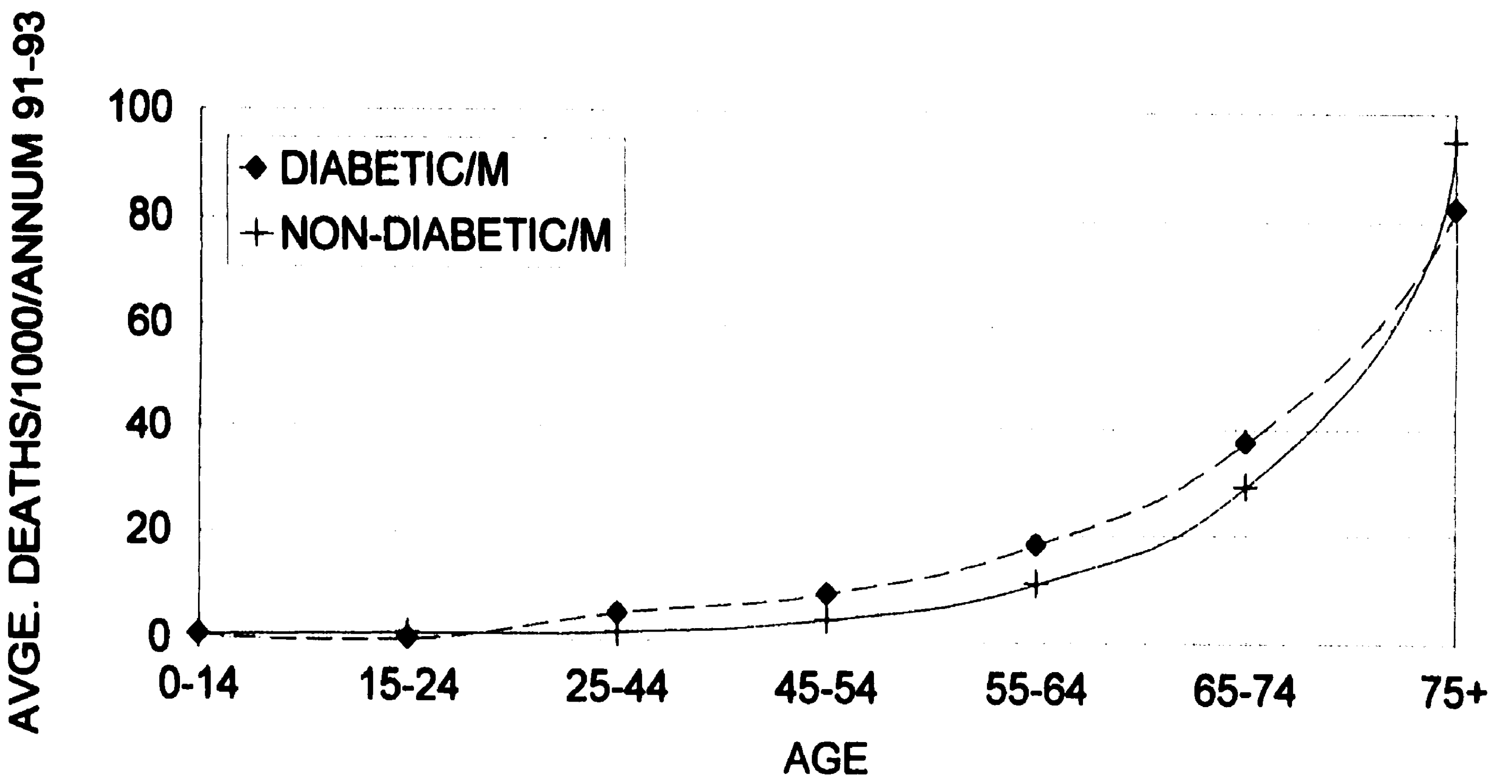
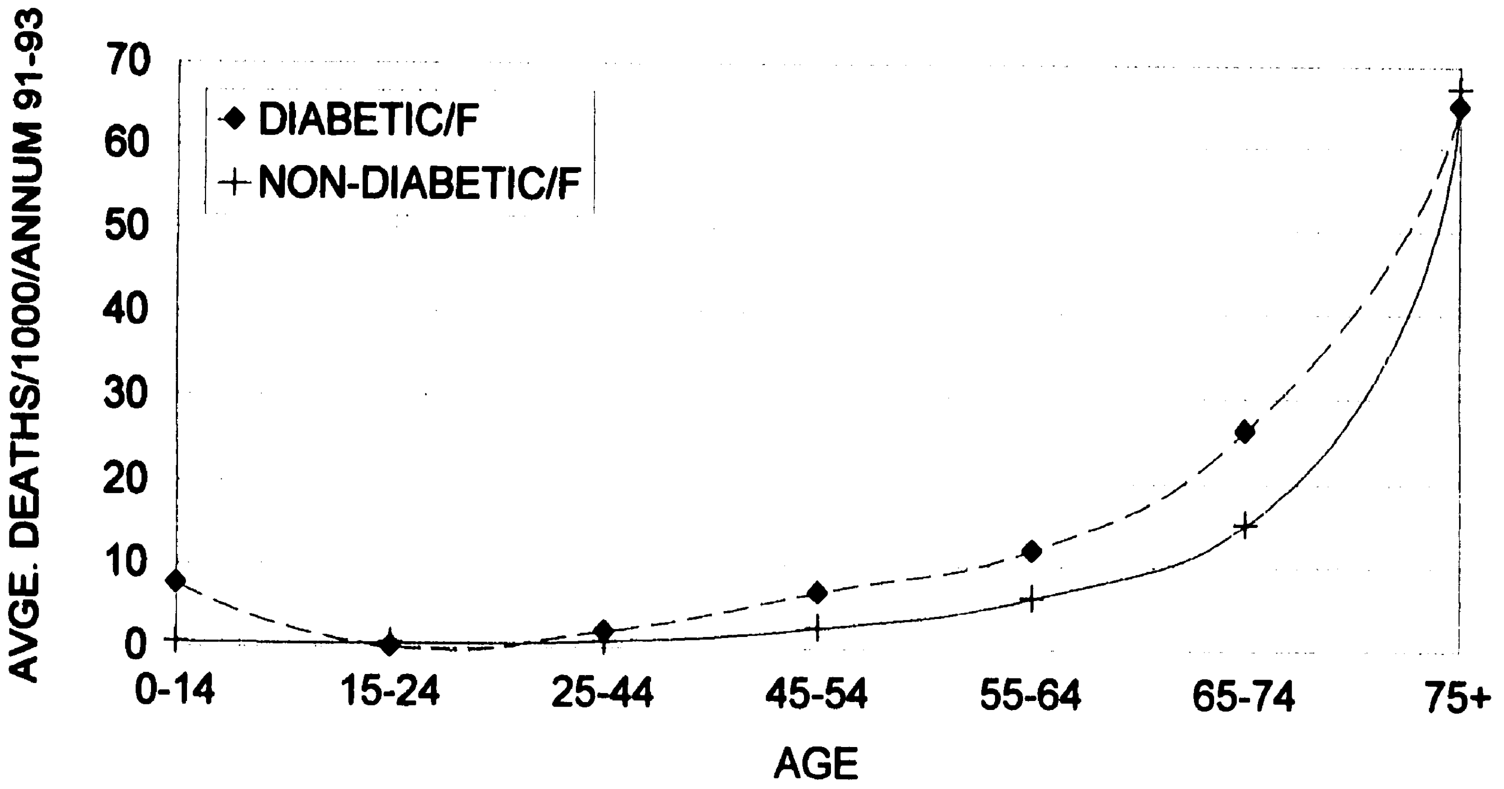


FIG.7 FEMALE AGE-SPECIFIC MORTALITY RATES MANITOBA



advantage of female gender was abrogated by diabetes, female diabetics having a mortality rate in excess of non-diabetic males.

5.1.6 Standardized Diabetes-Related Premature Mortality by Region

Premature mortality, when measured as mortality before age 75, as a global health status indicator, revealed a two fold excess in premature deaths for diabetics, both those living inside and outside Winnipeg (Table 19). The premature mortality risk imposed by diabetes was least apparent for regions of low socioeconomic status, possibly related to the excess mortality that social deprivation imposes on the non-diabetic population, or under-diagnosis of diabetes in this group. Therefore, although the core area of Winnipeg revealed profound premature mortality at approximately 8 deaths per thousand per year, this was balanced by a significant excess mortality in the non-diabetic population in that region.

5.2 Impact of Treaty Status on Patterns of Hospital Utilization for Diabetic and Non-Diabetic Populations

Table 20 indicates that for the non-treaty population, persons with diabetes accounted for 10% of hospital separations. Again, although diabetes was present in approximately 5% of the total population, it was responsible for 10% of hospitalizations in the non-treaty population. The impact of treaty status was dramatic, where diabetes accounted for 15% of hospital separations. (Odds Ratio 1.61;95% CI 1.54-1.68).

Analysis of the 45,117 persons with diabetes revealed that 76% of treaty status diabetes patients had been hospitalized during the year, compared to 43% of the non-treaty status diabetes patients. (Odds Ratio 4.16; 95% CI 3.84-4.51).

TABLE 19

STANDARDIZED DIABETES 0-74 MORTALITY (AVERAGE PREMATURE DEATHS/ANNUM/1000)

REGION	DIABETIC	NON-DIABETIC	RATIO
NON-WINNIPEG	6.03	3.07	2.0
CENTRAL	6.99	2.74	2.5
INTERLAKE	5.55	3.59	1.5
EASTMAN	5.63	2.74	2.1
WESTMAN	5.63	2.72	2.1
PARKLAND	7.73	2.81	2.8
NORMAN	6.97	4.62	1.5
THOMPSON	5.55	4.42	1.3
WINNIPEG	6.21	3.16	2.0
INNER CORE	8.74	6.81	1.3
OUTER CORE	7.22	3.83	1.9
ST. BONIFACE	5.49	4.49	1.4
SOUTH-CENTRAL	6.38	2.53	2.5
WEST	6.78	2.98	2.3
NORTHWEST	3.92	2.81	1.4
NORTHEAST	5.46	2.67	2.0
SOUTHEAST	4.25	2.55	1.7
SOUTHWEST	5.92	2.63	2.20

TABLE 20

MANITOBA DIABETES HOSPITALIZATION BY TREATY STATUS

Treaty Status	Hospitalizations for Persons with Diabetes	Hospitalizations for Persons without Diabetes
Treaty	2,694	14,750
Non-Treaty	17,802	156,660
	20,496	171,410

Odds Ratio 1.61
95% Confidence Interval (1.54-1.68)

Comparing measures of hospital utilization according to geographic region and treaty status revealed that on average the two fold excess risk of hospitalization imposed by diabetes was slightly diminished for the treaty population whether within the city of Winnipeg or without (Table 21). However, while the ratio of diabetic versus non-diabetic utilization was slightly diminished for the treaty population, the overall magnitude of hospital utilization was at least two fold greater for diabetics with treaty status and even greater for those who were non-diabetic (Figure 8). This relative excess of hospital utilization for non-diabetics with treaty status accounted for the slight reduction in impact of diabetes on hospitalization when comparing those with treaty and non-treaty status. This analysis also revealed that while the length of hospital stay for native diabetics exceeded native non-diabetics by 50 to 60%, the absolute length of hospital stay was shorter for persons with treaty status in general, regardless of hospitalization region.

5.2.0 Diabetes Hospitalizations According to Length of Stay by Region and Treaty Status

Length of stay analysis for Winnipeg revealed that the relative impact of diabetes in persons of treaty status was reduced for short stays (1 - 8 days) as well as for hospital stays of 3 or more weeks duration (Table 22). In particular, diabetics with treaty status had a significant excess hospitalization for hospital stays of 9 - 14 days, a four fold greater hospital utilization compared to non-diabetics with treaty status.

A similar analysis for persons living outside Winnipeg (Table 23) revealed a dramatic excess utilization of short hospital stay for diabetics with treaty status and unlike Winnipeg, an excess risk of long stay hospitalization with three and a half times the risk for long stay hospital care.

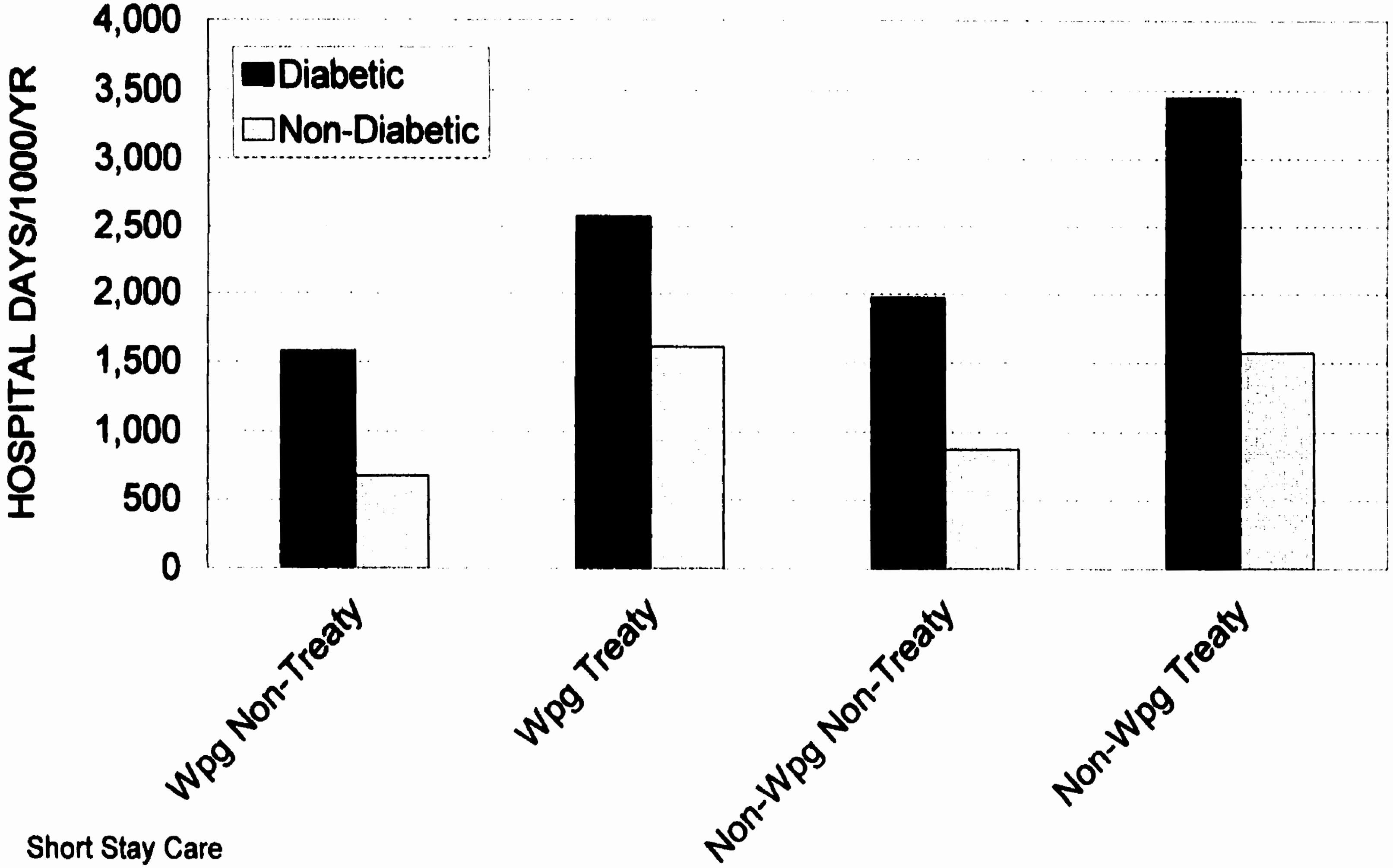
TABLE 21

MANITOBA DIABETES HOSPITALIZATIONS BY TREATY STATUS AND REGION (91-92)

(Short Stay Inpatient Care)

WINNIPEG	Non-Treaty Diabetic	Non-Treaty Non-diabetic	Ratio	Treaty Diabetic	Treaty Non-diabetic	Ratio
SEPARATIONS/1000	217.7	93.3	2.3	402.4	257.7	1.6
PERSONS/1000	153.8	74.6	2.1	266.4	180.9	1.5
READMISSIONS/1000	63.9	18.7	3.4	136.0	77.71	1.7
HOSPITAL DAYS/1000	1578.0	676.6	2.3	2574.2	1612.7	1.6
AVG. LOS	10.2	7.0	1.5	7.3	4.5	1.6
NON-WINNIPEG						
SEPARATIONS/1000	318.2	143.2	2.2	627.16	314.4	2.0
PERSONS/1000	227.3	109.7	2.1	405.6	220.9	1.8
READMISSION/1000	90.9	33.5	2.7	221.6	93.5	2.4
HOSPITAL DAYS/1000	1973.8	876.9	2.2	3450.0	1572.1	2.2
AVG. LOS	8.5	6.1	1.4	6.3	4.2	1.5

Fig.8 STANDARDIZED DIABETES HOSPITALIZATIONS BY TREATY STATUS AND REGION 1991/92



Short Stay Care

TABLE 22

DIABETIC AND NON-DIABETIC HOSPITALIZATIONS IN MANITOBA ACCORDING TO LENGTH OF STAY BY REGION AND TREATY STATUS

Winnipeg Hospitalizations (Hospital Days/1000)

	Non-Treaty			Treaty		
Length of Stay (Days)	Diabetic (column %)	Non-diabetic (column %)	Ratio	Diabetic (column %)	Non-Diabetic (column %)	Ratio
1-8	542.7 (21)	238.3 (18)	2.3	854.0 (23)	646.9 (22)	1.3
9-14	274.4 (11)	121.0 (9)	2.3	971.2 (26)	249.5 (9)	3.9
15-22	234.0 (9)	99.7 (7)	2.3	404.0 (11)	183.8 (6)	2.2
23-59	526.9 (20)	217.5 (16)	2.4	345.1 (9)	532.6 (18)	0.6
60 +	1018.8 (39)	676.2 (50)	1.5	1131.8 (31)	1332.5 (45)	0.8
TOTAL	2596.8(100)	1352.7(100)	1.9	3706.1(100)	2945.3(100)	1.3

TABLE 23

DIABETIC AND NON-DIABETIC HOSPITALIZATIONS IN MANITOBA ACCORDING TO LENGTH OF STAY BY REGION AND TREATY STATUS

Non-Winnipeg Hospitalizations (Hospital Days/1000)

	Non-Treaty			**Treaty**		
Length of Stay (Days)	Diabetic (column %)	Non-Diabetic (column %)	Ratio	Diabetic (column %)	Non-Diabetic (column %)	Ratio
1 - 8	897.6 (34)	390.1 (31)	2.3	1703.5 (42)	803.7 (46)	2.1
9 - 14	380.0 (14)	165.4 (13)	2.3	569.3 (14)	283.5 (10)	2.0
15 - 22	257.3 (10)	120.5 (10)	2.1	435.2 (11)	231.1 (12)	2.0
23 - 59	438.8 (17)	200.7 (16)	2.2	741.9 (18)	271.8 (15)	2.7
60 +	647.8 (25)	378.9 (30)	1.8	639.3 (16)	184.8 (11)	3.5
TOTAL	2648.5(100)	1255.6(100)	2.1	4089.2(100)	1756.9(100)	2.3

5.2.1 <u>Diabetes Hospitalizations According to Level of Care by Region and Treaty Status</u>

Winnipeg diabetics with treaty status received the majority of their care at core area teaching hospitals while persons of non-treaty status received a large proportion of their care at urban community hospitals as well as teaching hospitals (Table 24). Utilization of major rural hospitals was significantly increased in Winnipeg persons with treaty status, likely representing the fact that many of these persons had emigrated to the city at an earlier date and were thus returning to home hospitals.

For non-Winnipeg hospitalizations there was an increased use of specialized teaching hospital care for persons of treaty status and this level of utilization actually exceeded that of major rural hospitals, the primary site of care for persons with treaty status living outside Winnipeg.

5.2.2 <u>Diabetes Hospitalizations According to Complexity of Care by Region and Treaty Status</u>

Stratifying by complexity of care continued to demonstrate the pervasive impact of diabetes on increasing hospital utilization regardless of treaty status and Winnipeg residency (Table 25). Patients with treaty status in Winnipeg had the majority of their hospitalizations categorized as being of moderate complexity while the majority of non-treaty Winnipeg admissions were of low complexity. There was little difference between relative complexity by treaty status for diabetics admitted outside Winnipeg.

TABLE 24
DIABETIC AND NON-DIABETIC HOSPITALIZATIONS IN MANITOBA ACCORDING TO LEVEL OF CARE BY REGION AND TREATY STATUS

Hospitalizations for Winnipeg Residents (Hospital Days/1000)

	Non-Treaty			Treaty		
Level of Care	Diabetic (column %)	Non-Diabetic (column %)	Ratio	Diabetic (column %)	Non-Diabetic (column %)	Ratio
Teaching	808.0 (51)	306.6 (45)	2.6	1519.4 (59)	1053.7 (65)	1.4
Urban Community	669.7 (42)	322.0 (48)	2.1	308.0 (12)	209.3 (13)	1.5
Major Rural	7.8 (0.4)	4.6 (1)	1.7	449.6 (17)	168.0 (10)	2.7
Other	92.5 (6)	43.4 (6)	2.1	297.2 (12)	181.7 (11)	1.6
TOTAL	1578.0(100)	676.6(100)	2.3	2574.2(100)	1612.7(100)	1.6

Non-Winnipeg Hospitalizations (Hospital Days/1000)

	Non-Treaty			Treaty		
Level of Care	Diabetic (column %)	Non-Diabetic (column %)	Ratio	Diabetic (column %)	Non-Diabetic (column %)	Ratio
Teaching	419.5 (21)	158.3 (18)	2.6	1184.0 (34)	465.2 (30)	2.5
Urban Community	355.0 (18)	184.3 (21)	1.9	389.0 (11)	143.3 (9)	2.7
Major Rural	534.1 (27)	230.6 (26)	2.3	889.8 (26)	451.9 (29)	2.0
Other	665.2 (34)	303.1 (35)	2.2	987.1 (29)	511.8 (32)	1.9
TOTAL	1973.8(100)	876.8(100)	2.2	3450.0(100)	1572.2(100)	2.2

TABLE 25
DIABETIC AND NON-DIABETIC HOSPITALIZATIONS IN MANITOBA ACCORDING TO COMPLEXITY OF CARE BY REGION AND TREATY STATUS

Winnipeg Hospitalizations (Hospital Days/1000)

	Non-Treaty			**Treaty**		
Complexity of Care	Diabetic (column %)	Non-Diabetic (column %)	Ratio	Diabetic (column %)	Non-Diabetic (column %)	Ratio
Low	648.8 (41)	356.5 (53)	1.8	918.2 (36)	708.5 (44)	1.3
Moderate	596.2 (38)	175.3 (26)	3.4	1245.8 (49)	691.1 (43)	1.8
High	333.0 (21)	144.8 (21)	2.3	410.2 (16)	213.2 (13)	1.9
TOTAL	1578.0(100)	676.6(100)	2.3	2524.2(100)	1612.8(100)	1.6

Non-Winnipeg Hospitalizations (Hospital Days/1000)

	Non-Treaty			**Treaty**		
Complexity of Care	Diabetic (column %)	Non-Diabetic (column %)	Ratio	Diabetic (column %)	Non-Diabetic (column %)	Ratio
Low	1053.3 (53)	572.3 (65)	1.8	1596.7 (46)	934.0 (59)	1.7
Moderate	664.4 (34)	191.1 (22)	3.5	1300.6 (38)	421.3 (27)	3.1
High	256.1 (13)	113.5 (13)	2.2	552.7 (16)	216.8 (14)	2.5
TOTAL	1973.8(100)	877.0(100)	2.2	3450.0(100)	1572.1(100)	2.2

5.2.3 Manitoba Diabetes Hospitalizations According to Intensity of Care by Region and Treaty Status

Stratifying diabetes hospitalizations by intensity of care demonstrated a similar excess risk of diabetic hospitalization whether for treaty or non-treaty status (Table 26). It is noteworthy that for residents outside Winnipeg, days of care by diabetics with treaty status for conditions requiring very high intensity of care were 3.4 times that of non-diabetics.

5.2.4 Manitoba Diabetes Hospitalizations According to Discretionary Nature of Admission by Region and Treaty Status

The excess risk of hospitalization imposed by diabetes was maintained for persons of treaty status when stratified according to discretionary nature of the admission and as expected the majority of admissions were represented by medical admissions for conditions associated with high variation in admission rate (Table 27). However, the excess risk of admission was maintained for low variation medical admissions and surgical procedures. An excess risk for obstetrical admissions for diabetics remained regardless of treaty status, and in fact persons of treaty status living outside Winnipeg were at greatest excess risk of hospitalization, at a rate three times that of the non-diabetic population.

5.2.5 Manitoba Diabetes Hospitalizations According to Type of Stay by Region and Treaty Status

Stratifying the analysis by type of stay revealed that diabetes imposed an excess risk for all types of stay except for treaty status diabetics, where there was no increased

TABLE 26

DIABETIC AND NON-DIABETIC HOSPITALIZATIONS IN MANITOBA ACCORDING TO INTENSITY OF CARE BY REGION AND TREATY STATUS

Winnipeg Hospitalizations (Hospital Days/1000)

	Non-Treaty			Treaty		
	Diabetic (column %)	Non-Diabetic (column %)	Ratio	Diabetic (column %)	Non-Diabetic (column %)	Ratio
Very Low	137.3 (9)	67.1 (10)	2.0	503.5 (20)	191.1 (12)	2.6
Intermediate	1237.5 (78)	513.6 (76)	2.4	1818.3 (70)	1277.3 (79)	1.4
Very High	203.2 (13)	95.8 (4)	2.1	252.4 (10)	144.3 (9)	1.7
TOTAL	1578.0(100)	676.5(100)	2.3	2574.2(100)	1612.7(100)	1.6

Non-Winnipeg Hospitalizations (Hospital Days/1000)

	Non-Treaty			Treaty		
	Diabetic (column %)	Non-Diabetic (column %)	Ratio	Diabetic (column %)	Non-Diabetic (column %)	Ratio
Very Low	198.9 (10)	107.2 (12)	1.8	492.9 (14)	206.0 (13)	2.4
Intermediate	1629.3 (83)	683.9 (78)	2.4	2577.8 (75)	1255.8 (80)	2.0
Very High	145.6 (7)	85.8 (10)	1.7	379.2 (11)	110.3 (7)	3.4
TOTAL	1973.8(100)	768.9(100)	2.2	3449.9(100)	1572.1(100)	2.2

TABLE 27

DIABETIC AND NON-DIABETIC HOSPITALIZATIONS IN MANITOBA ACCORDING TO DISCRETIONARY NATURE OF ADMISSIONS BY REGION AND NATIVE STATUS

Winnipeg Hospitalizations (Hospital Days/1000)

	Non-Native			**Native**		
	Diabetic (column %)	Non-Diabetic (column %)	Ratio	Diabetic (column %)	Non-Diabetic (column %)	Ratio
High variation medical	960.6 (61)	353.6 (52)	2.7	1718.0 (67)	1082.5 (67)	1.6
Surgical	392.5 (25)	208.6 (31)	1.9	580.4 (22)	365.5 (23)	1.6
Low variation	140.0 (9)	72.8 (11)	1.9	100.3 (4)	61.8 (4)	1.6
Obstetric	85.1 (5)	41.7 (6)	2.0	175.6 (7)	102.9 (6)	1.7
TOTAL	1578.1(100)	676.7(100)	2.3	2574.3(100)	1612.7(100)	1.6

Non-Winnipeg Hospitalizations (Hospital Days/100)

	Non-Native			**Native**		
	Diabetic (column %)	Non-Diabetic (column %)	Ratio	Diabetic (column %)	Non-Diabetic (column %)	Ratio
High variation medical	1337.3 (68)	530.3 (60)	2.5	2149.8 (62)	1045.8 (66)	2.0
Surgical	404.1 (20)	220.3 (25)	1.8	778.7 (23)	313.8 (20)	2.5
Low variation	134.9 (7)	73.3 (8)	1.8	120.2 (3)	84.3 (5)	1.4
Obstetric	97.5 (5)	53.0 (6)	1.8	401.2 (12)	128.2 (8)	3.1
TOTAL	1973.8(100)	876.9(100)	2.2	3449.9(100)	1572.1(100)	2.2

TABLE 28

DIABETIC AND NON-DIABETIC HOSPITALIZATIONS IN MANITOBA ACCORDING TO TYPE OF STAY BY REGION AND NATIVE STATUS

Winnipeg Hospitalizations (Hospital Days/1000)

	Non-Native			Native		
	Diabetic (column %)	Non-Diabetic (column %)	Ratio	Diabetic (column %)	Non-Diabetic (column %)	Ratio
Adult Surgical	420.7 (27)	225.4 (33)	1.9	553.1 (21)	321.9 (20)	1.7
Adult Medical	780.4 (49)	299.9 (44)	2.6	1647.8 (64)	990.8 (62)	1.6
Obstetrical	122.6 (8)	57.5 (9)	2.1	230.5 (9)	142.4 (9)	1.6
Psychiatric	150.5 (10)	63.1 (9)	2.4	36.1 (2)	52.8 (3)	0.7
Pediatric	103.8 (6)	30.7 (5)	3.4	106.7 (4)	104.8 (6)	1.0
TOTAL	1578.0(1000)	676.6(100)	2.3	2574.2(100)	1612.7(100)	1.6

Non-Winnipeg Hospitalizations (Hospital Days/1000)

	Non-Native			Native		
	Diabetic (column %)	Non-Diabetic (column %)	Ratio	Diabetic (column %)	Non-Diabetic (column %)	Ratio
Adult Surgical	399.4 (20)	229.9 (26)	1.7	792 (23)	298 (19)	2.7
Adult Medical	1244.1 (63)	483.6 (55)	2.6	1936.2 (56)	888.2 (56)	2.2
Obstetrical	157.5 (8)	72.0 (8)	2.2	495.0 (14)	171.0 (11)	2.9
Psychiatric	54.6 (3)	38.5 (4)	1.4	33.1 (1)	28.5 (2)	1.2
Pediatric	118.3 (6)	52.8 (6)	2.2	193.6 (6)	186.5 (12)	1.0
TOTAL	1973.9(100)	876.8(100)	2.2	3449.9(100)	1572.2(100)	2.2

risk of use of psychiatric or pediatric days of care (Table 28). The marked excess risk for obstetrical admissions for persons of treaty status living outside Winnipeg was again noted in this analysis.

5.3 Diabetes Complications: Hospital Utilization, Regional Variations and Impact of Treaty Status

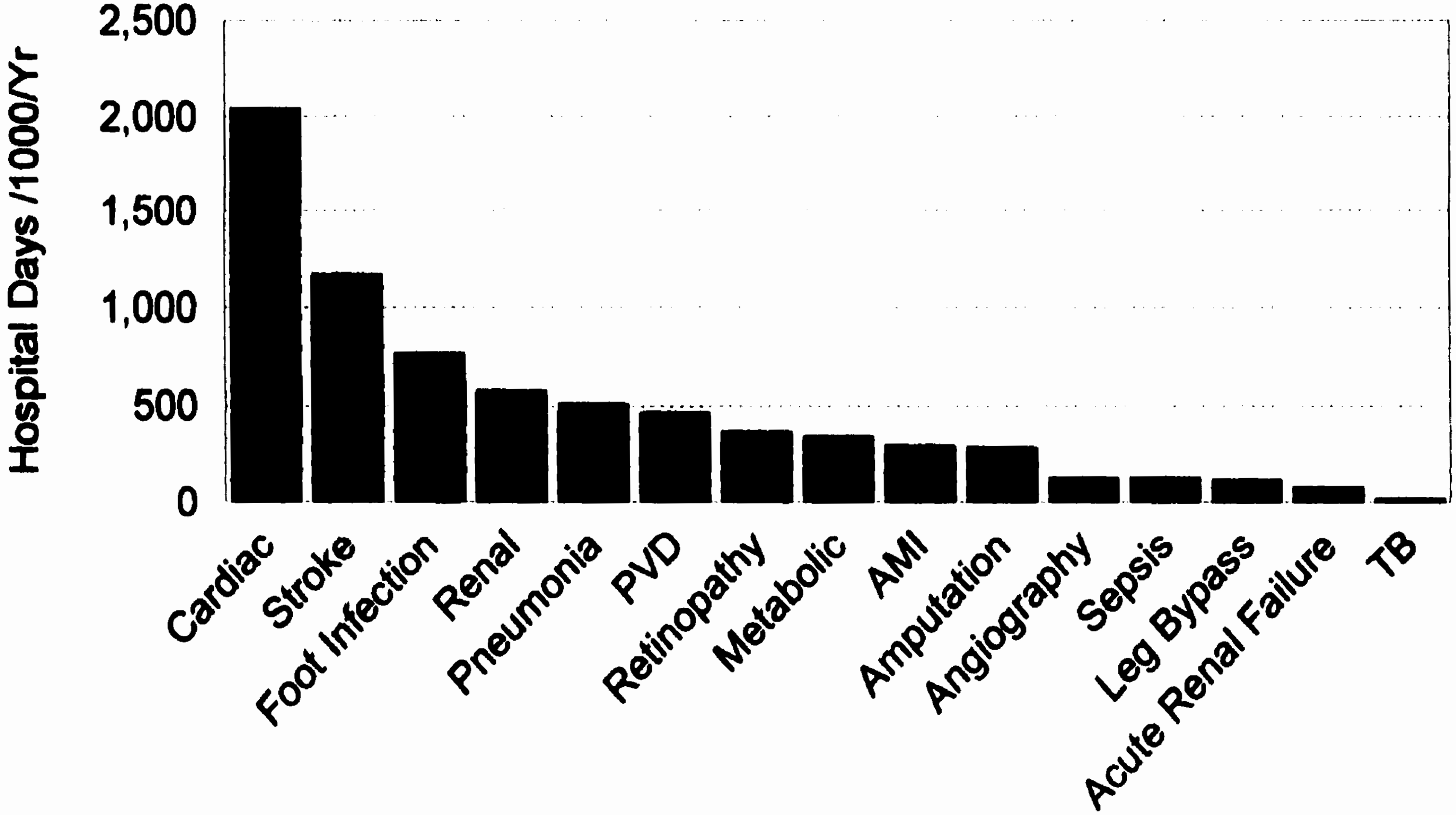
5.3.0 Complication Specific Admission Rates

Comparisons within the diabetic population were carried out by using the age and gender characteristics of the diabetes cohort as the standard population. Using the ICD-9 criteria described in Appendix A, disease specific hospital use was measured as hospital days per 1000. (Fig. 9). This initial analysis measured total utilization of hospital beds for disease categories appearing either as the primary or subsidiary diagnosis on the hospital abstracts. This demonstrated the immense impact of cardiovascular disease among diabetics, where there was an excess of 2,000 hospital days per 1,000 (where cardiac disease was defined as all codes pertaining to ischemic heart disease, sudden death, cardiac procedures and congestive heart failure). This was followed by stroke at greater than 1,000 hospital days per 1,000. Foot infection represented the third most common explanation for use of hospital days, followed by renal admissions. Diagnostic codes for out-patient dialysis were excluded as these would have biased the hospital readmission rate by measuring routine hemodialysis care carried out in hospital (usually on a three times per week basis).

A more conservative measurement of disease specific hospitalization (Fig. 10) was obtained by choosing only diagnoses listed as the primary reason for admission (in

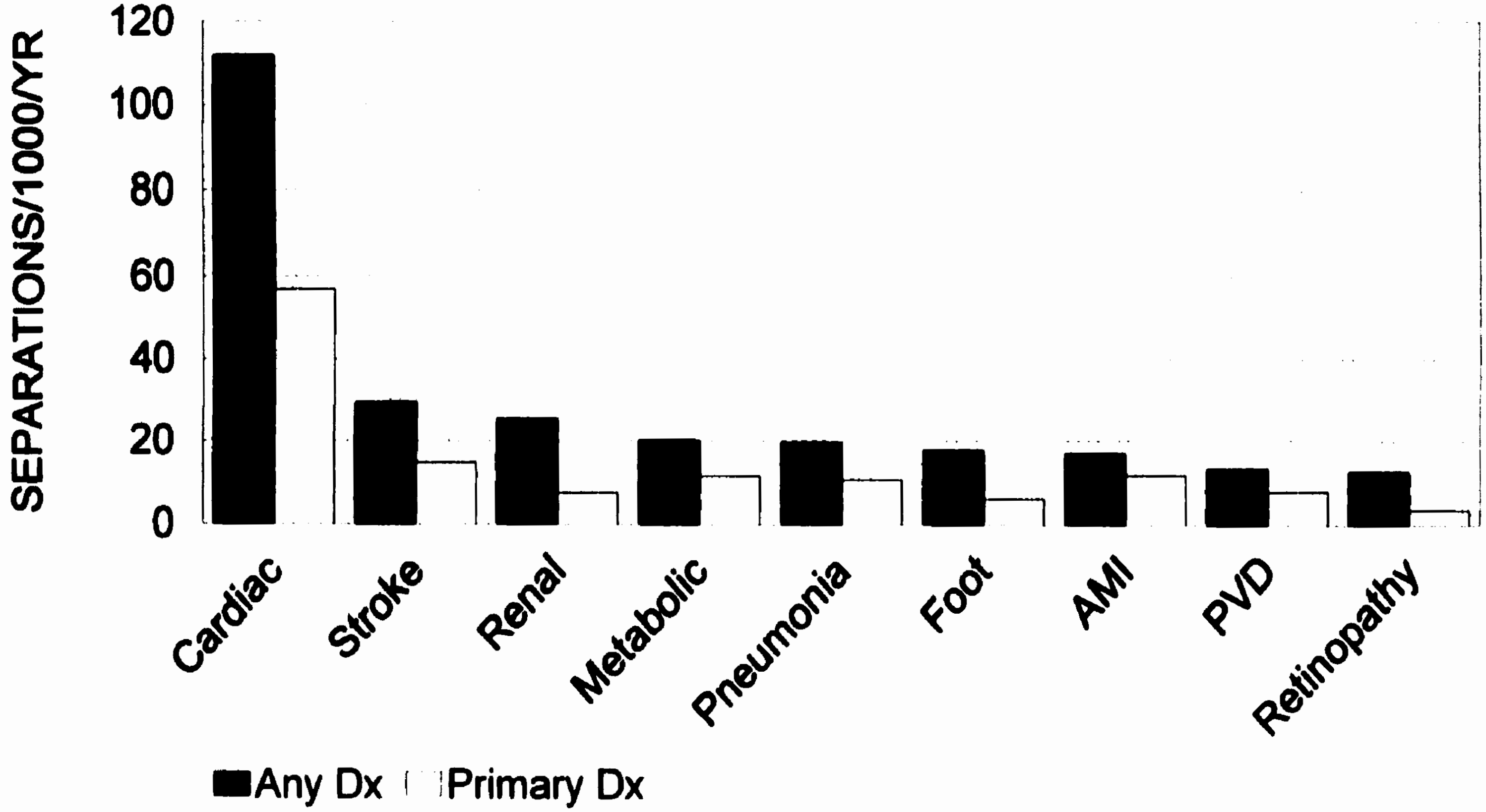
Fig.9 Diabetes Hospital Admissions 1991/92

Hospital Days Per 1000



Any of 16 Diagnoses

Fig.10 Manitoba Diabetes Separations for Diagnoses Appearing Anywhere on Abstract or as Primary Diagnosis



theory responsible for the majority of the hospital stay). This resulted in approximately a 50% reduction in hospital separation rates for all diagnoses, indicating that persons with diabetes were generally admitted with multiple co-morbidities. This analysis served to better define the primary reason for admission, and reduced the prominence of renal disease, foot infection and retinopathy, which tended to appear more often as a subsidiary rather than a primary diagnosis (Table 29). All subsequent analyses were carried out using the primary diagnosis for calculating rates of hospital utilization except for major procedures (angiography, bypass, amputation) which were counted regardless.

5.3.1 Complication Specific Readmission Rates

Previous analyses comparing diabetics to non-diabetics demonstrated a significant increased risk of readmission for diabetics versus non-diabetics. Further analysis of readmission rate by diagnostic category revealed that this was most prominent for renal and cardiovascular disease where the readmission rates exceeded 30% over one year (Fig. 11). This was followed by extremity complications (peripheral vascular disease and foot complications) which each had a readmission rate exceeding 15%.

Analysis of average length of stay revealed the significant impact of amputation with an average length of stay exceeding 9 weeks duration (Table 30). Hospitalizations for diagnoses indicative of peripheral limb complications such as peripheral vascular disease, peripheral angiography and limb bypass, as well as stroke admissions, all had an average length of stay exceeding 30 days.

5.3.2 Winnipeg versus Non-Winnipeg Diabetes Hospital Separations

Figure 12 shows the relative ratio of hospital separations between non-Winnipeg and Winnipeg regions. This revealed an excess overall rate of admission for renal

TABLE 29

MANITOBA DIABETES HOSPITALIZATIONS 1991/92

HOSPITAL SEPARATIONS : ANY Dx VS PRIMARY Dx

DIAGNOSIS	PRIMARY OR CONTRIBUTING DIAGNOSIS	PRIMARY DIAGNOSIS	RATIO
	(Sep. per 1000)	(Sep. per 1000)	
Cardiovascular Disease	111.8(42)	57.0 (44)	2.0
Stroke	29.6 (11)	14.6 (11)	2.0
Renal disease	25.2 (9)	7.4 (6)	3.4
Metabolic	19.9 (8)	11.5 (9)	1.7
Pneumonia	19.5 (7)	10.5 (8)	1.9
Foot Infection	17.7 (7)	6.0 (5)	3.0
Acute MI	16.9 (6)	11.7 (9)	1.4
PVD	13.3 (5)	7.8 (6)	1.7
Retinopathy	12.5 (5)	3.4 (3)	3.7
TOTAL	266.4 (100)	129.9 (100)	

Fig.11 Manitoba Diabetes Hospitalizations 91/92
Readmission Rates by Diagnostic Category

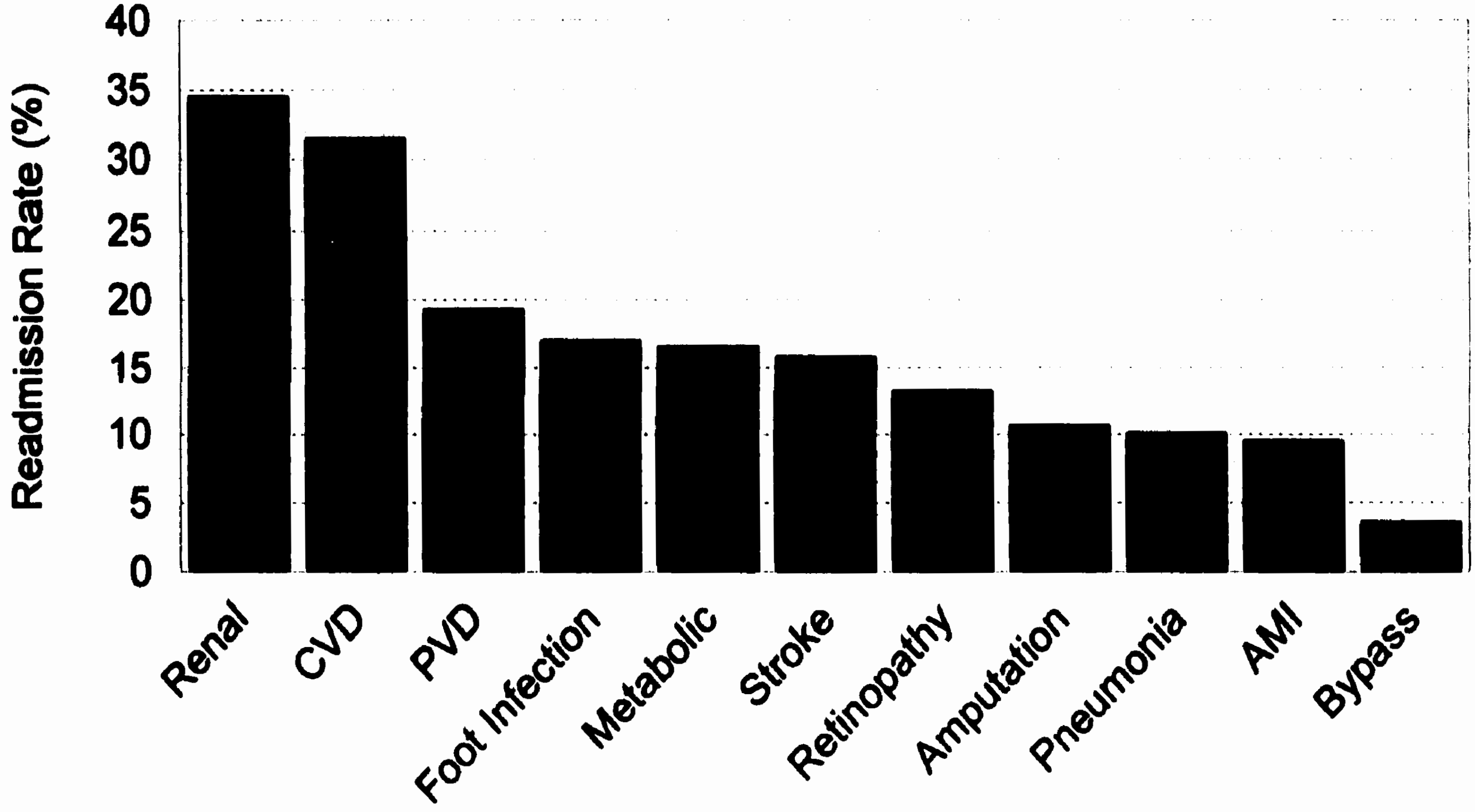


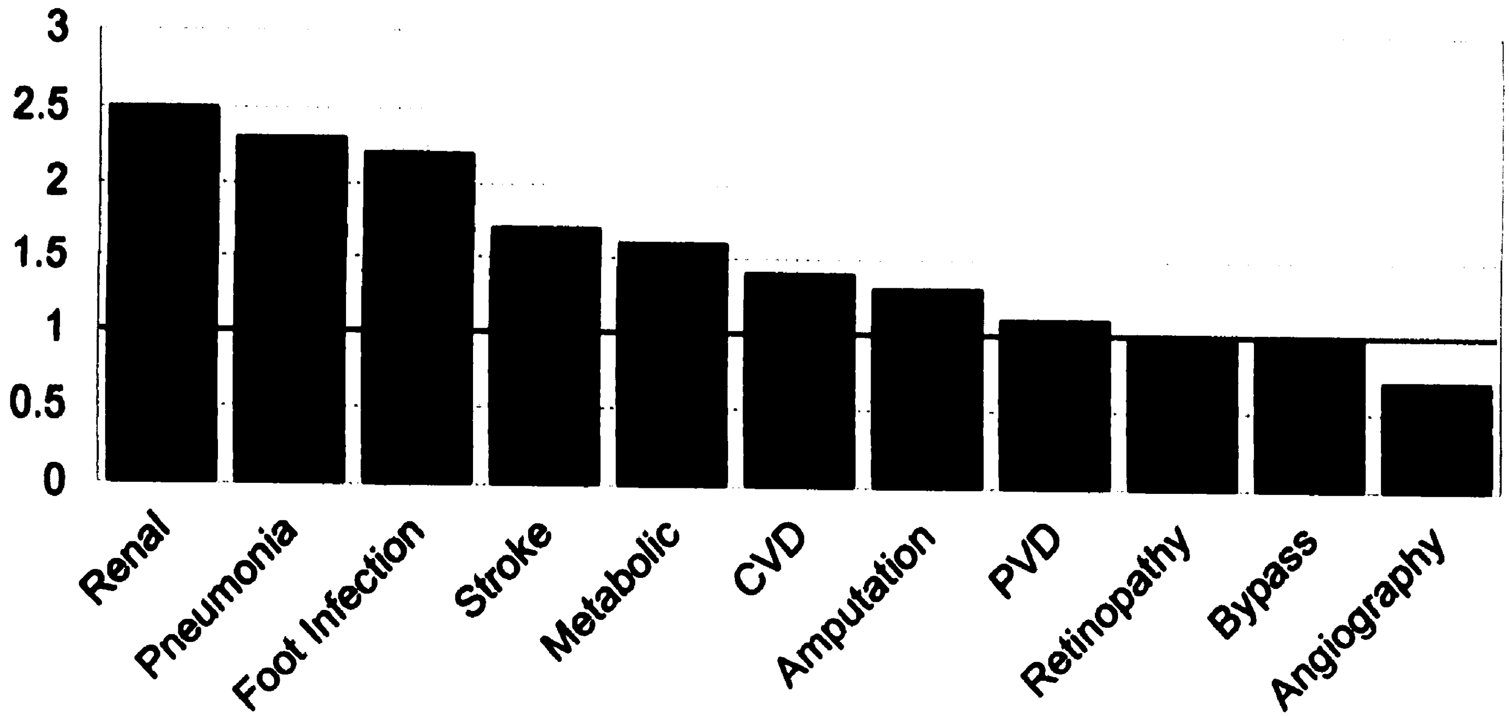
TABLE 30

MANITOBA DIABETES HOSPITALIZATIONS 1991/92

HOSPITAL UTILIZATION BY PRIMARY DIAGNOSIS

Diagnosis	#Admissions	Separations per 1000	Average LOS	Hospital Days per 1000	Percent Readmitted
Foot Infection	271	6.0	21.5	129.0	18.1%
PVD	353	7.8	35.9	280.6	19.6%
Angiography	223	4.9	41.3	204.2	6.7%
Limb Bypass	165	3.7	33.3	121.9	3.8%
Renal	332	7.4	13.6	99.9	37.9%
Acute Renal Failure	27	0.6	25.1	15.0	12.0%
Retinopathy	152	3.4	5.7	19.1	14.0%
Cardiac	2572	57.0	12.2	696.0	32.0%
Acute MI	528	11.7	11.3	132.3	9.5%
Pneumonia	476	10.5	10.0	105.1	10.5%
Metabolic	519	11.5	13.5	155.5	16.2%
Stroke	657	14.6	32.9	479.0	16.9%
Amputation	195	4.3	66.5	287.3	10.6%

Fig. 12 Manitoba Diabetes Hospital Admissions
Ratio of Separations/1000 Non-Winnipeg and Winnipeg
(1991/92)



disease, pneumonia, foot infection, stroke, metabolic complications, cardiovascular disease and amputation for persons living outside Winnipeg. Admission rates were similar across these 2 locations for most of the other disease specific admissions analyzed (Table 31). However, despite the excess amputation rate for persons living outside Winnipeg, admissions for peripheral angiography were below Winnipeg levels.

5.3.3 Macrovascular complications by Region

Subsequent review of admission rates by health region for macrovascular disease (stroke, acute MI and peripheral vascular disease) revealed an excess rate of stroke at all health regions outside Winnipeg except for Thompson (Fig. 13). Rates of admission for acute MI were similar across all regions except for Norman which demonstrated an extreme excess admission rate for acute MI at over twice that of other regions. Peripheral vascular disease was also high in the Norman region, as expected, in light of the high rate of acute MI. However, the Thompson region, which had the lowest rate of hospitalizations for acute MI in the province, also had the highest rate of peripheral vascular disease.

5.3.4 Microvascular Complications by Region

Analysis of microvascular complications (nephropathy, retinopathy and blindness) revealed a marked excess in renal separations for non-Winnipeg locations, with particular excesses in Norman and Thompson at 4 to 5 times the rate of Winnipeg separations (Fig. 14). Hospitalizations for retinal disease and blindness also showed marked but less extensive regional variation.

Fig.13 Manitoba Diabetes Hospitalizations 91/92
Vascular Complications By Region

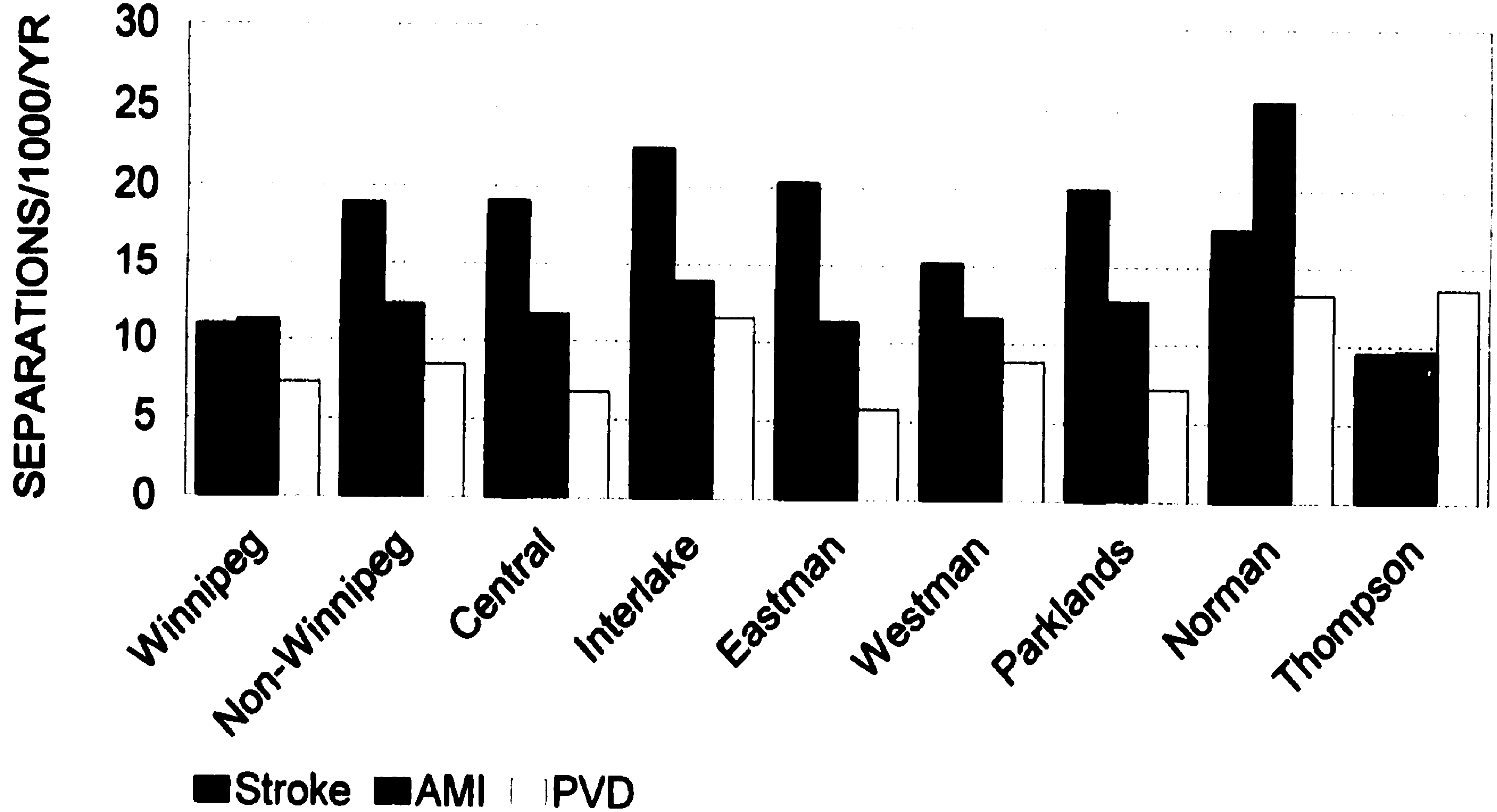


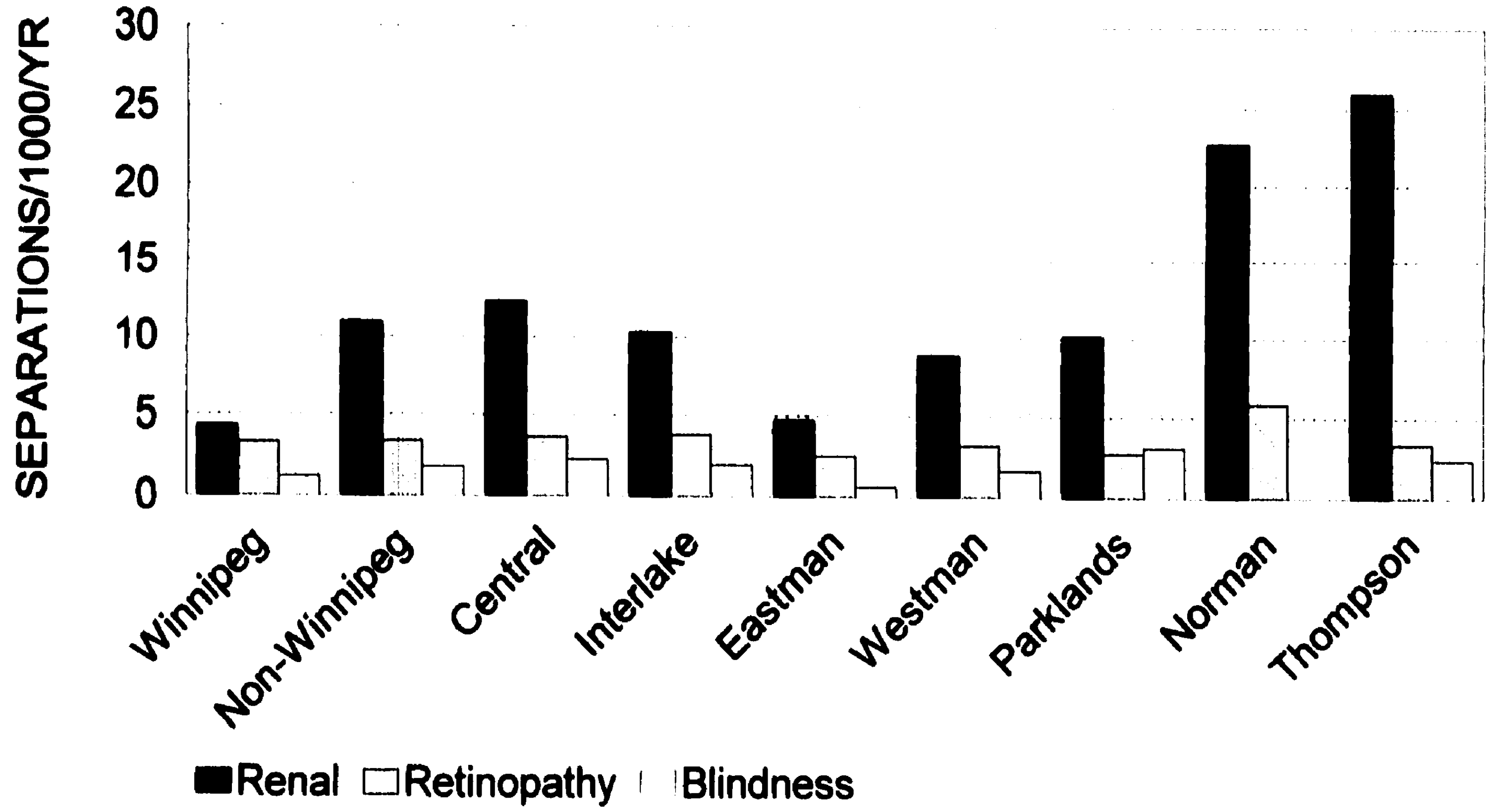
TABLE 31

DIABETES HOSPITAL ADMISSIONS 1991/92

WINNIPEG VS NON-WINNIPEG ADMISSIONS

DISEASE	NON-WINNIPEG (Sep/1000)	WINNIPEG (Sep/1000)	RATIO
Renal	10.9(7)	4.4(4)	2.5
Pneumonia	15.3(10)	6.5(6)	2.3
Foot Infection	8.4(5)	3.9(4)	2.1
Stroke	18.9(12)	10.9(11)	1.7
Metabolic	14.4(9)	9.2(9)	1.6
Cardiovascular Disease	67.4(43)	48.2(46)	1.4
Amputation	5.0(3)	3.7(4)	1.3
PVD	8.4(5)	7.3(7)	1.1
Retinal Disease	3.4(2)	3.4(3)	1.0
Bypass	3.7(2)	3.6(4)	1.0
Angiography (leg)	1.9(1)	2.6(2)	0.7
TOTAL	**157.7(100)**	**103.7(100)**	**1.5**

Fig.14 Manitoba Diabetes Hospitalizations 91/92
Microvascular Complications By Region



5.3.5 Infectious complications by Region

Admissions for pneumonia and foot infection showed a moderate but uniform increased admission rate for all rural regions except Norman and Thompson, where the excesses were immense (Fig. 15). This was particularly true for pneumonia admissions in Thompson, which were greater than 10 times those of Winnipeg residents.

5.3.6 Extremity Complications by Region

The marked variation in admissions for foot disease was assessed further by comparing rates of foot ulcer admission to admissions for leg bypass procedures, and extremity amputations; the former being a marker for interventions at the level of tertiary prevention, designed to decrease amputation, and the latter a marker for the ultimate outcome of extremity complications (Fig, 16). This analysis revealed a uniform similar rate of admission for foot infection, surgical bypass and amputation in Winnipeg. Non-Winnipeg residents experienced far greater risks of hospitalization for foot infection as previously documented, a lower relative rate of surgical bypass and a higher rate of amputation. Theoretically, the ratio of foot disease rate to peripheral arterial bypass rate should be related to the ultimate rate of amputation as high rates of foot ulcers increase amputation rates, while revascularization reduces amputation rates. Comparison of this ratio between regions did show a correlation with the highest foot disease-bypass ratios in those sites of highest amputation rate. A similar analysis for health regions within Winnipeg revealed an identical pattern, (Fig. 17) as sites where ulceration rates relative to the bypass rates were highest, had higher overall amputation rates.

Fig.15 Manitoba Diabetes Hospitalizations 91/92
Infectious Complications

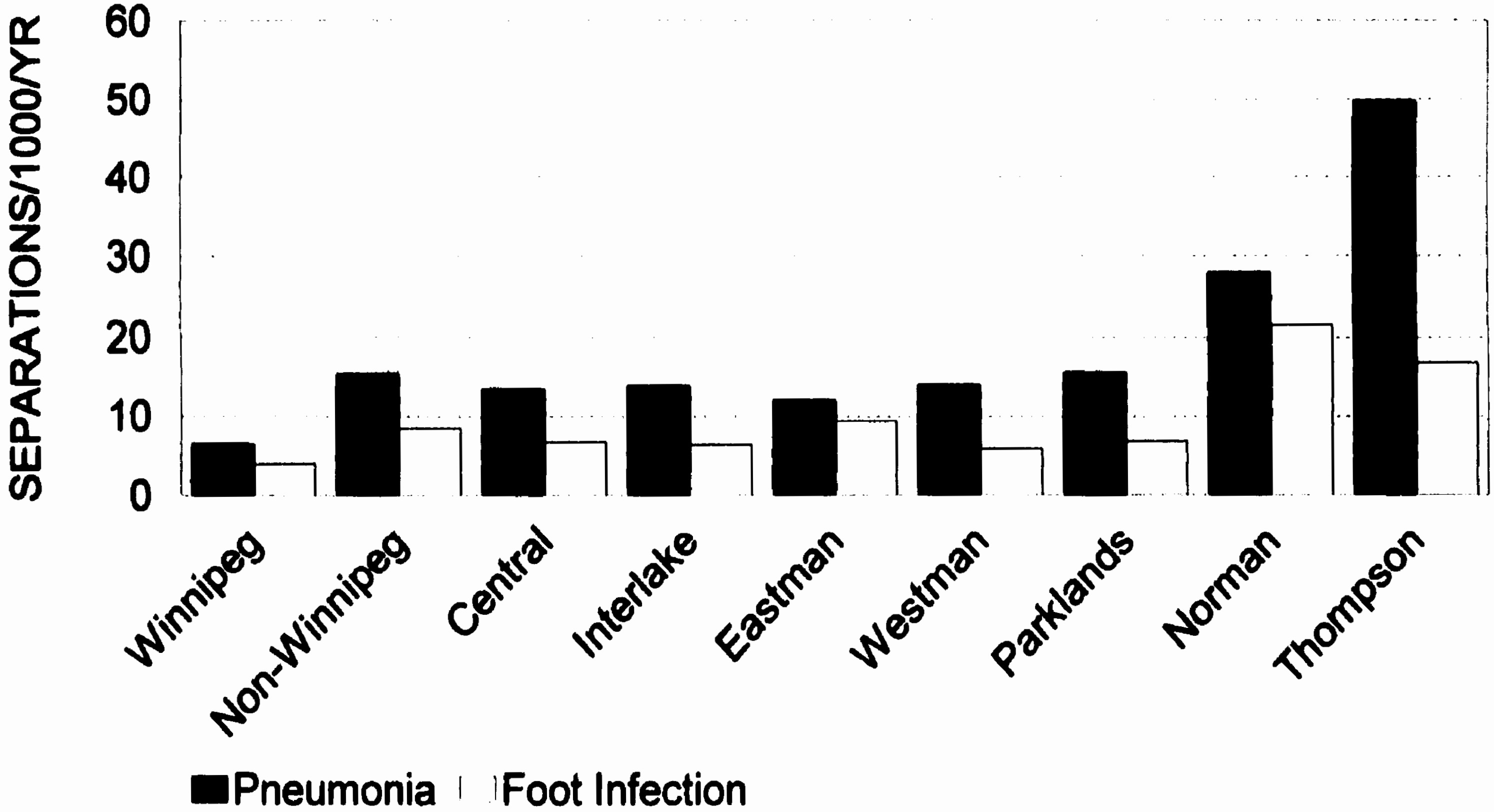


Fig.16 MANITOBA DIABETES HOSPITALIZATIONS 91/92
AMPUTATION RATE BY ULCER/BYPASS RATIO

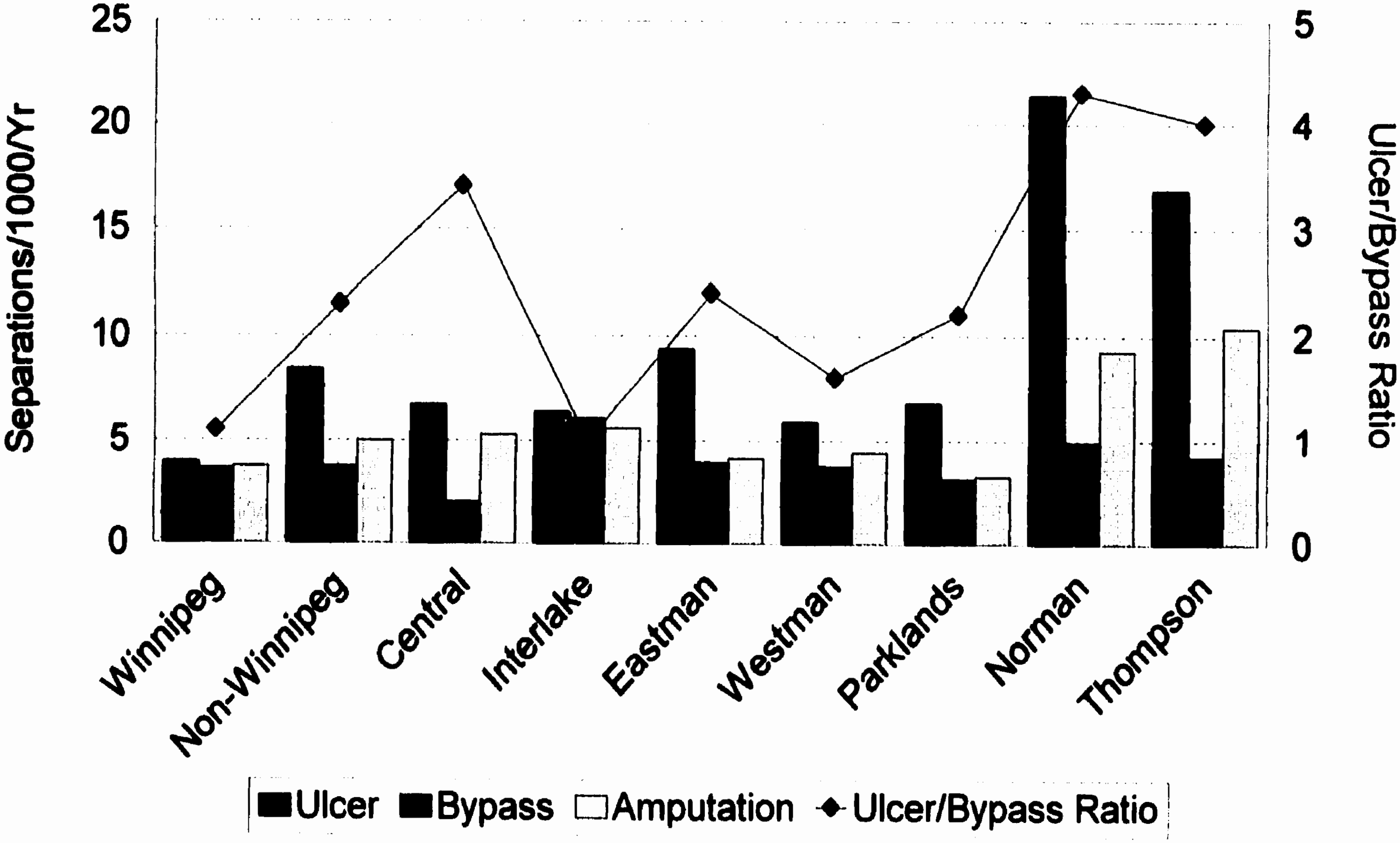
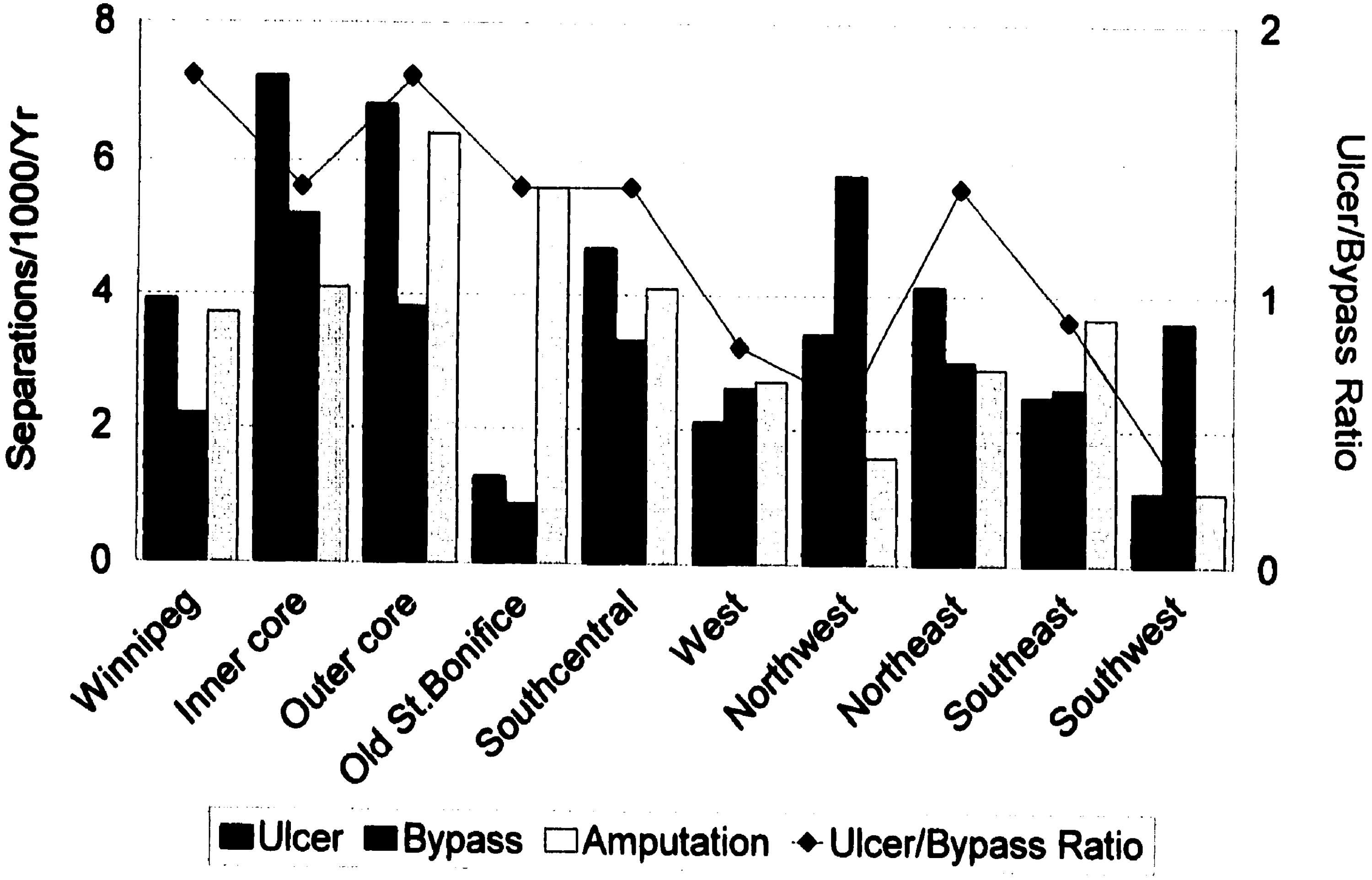


Fig.17 MANITOBA DIABETES HOSPITALIZATIONS 91/92
EXTREMITY COMPLICATIONS:WINNIPEG



5.3.7 Metabolic Complications by Region

Admissions for metabolic complications were higher for health regions outside Winnipeg and were most prominent in Westman and Central regions (Fig. 18).

5.3.8 Geographic Variation in Readmission Rates for Manitoba Diabetics by Disease Category

This analysis revealed an excess rate of hospital readmission at 1.5 times or greater from that of Winnipeg for acute MI, foot complications, renal disease, pneumonia and stroke (Fig. 19). This analysis also revealed higher Winnipeg admissions for retinopathy and glycemic control.

5.3.9 Manitoba Diabetes Disease Specific Admissions by Treaty Status

Winnipeg diabetes admissions for persons with treaty status revealed profound excesses for most diagnoses except stroke and amputation (Fig. 20). This excess hospitalization was most marked for pneumonia at 7.5 times that of the non-treaty diabetic population, but was also significantly increased for foot complications, renal disease and metabolic problems (Table 32).

Analysis of persons with treaty status resident outside of Winnipeg revealed a similar pattern (Fig. 21), except that the excess morbidity associated with treaty status was particularly prominent for amputation when compared to Winnipeg (Table 33).

Fig.18 Manitoba Diabetes Hospitalizations 91/92
Metabolic Complications

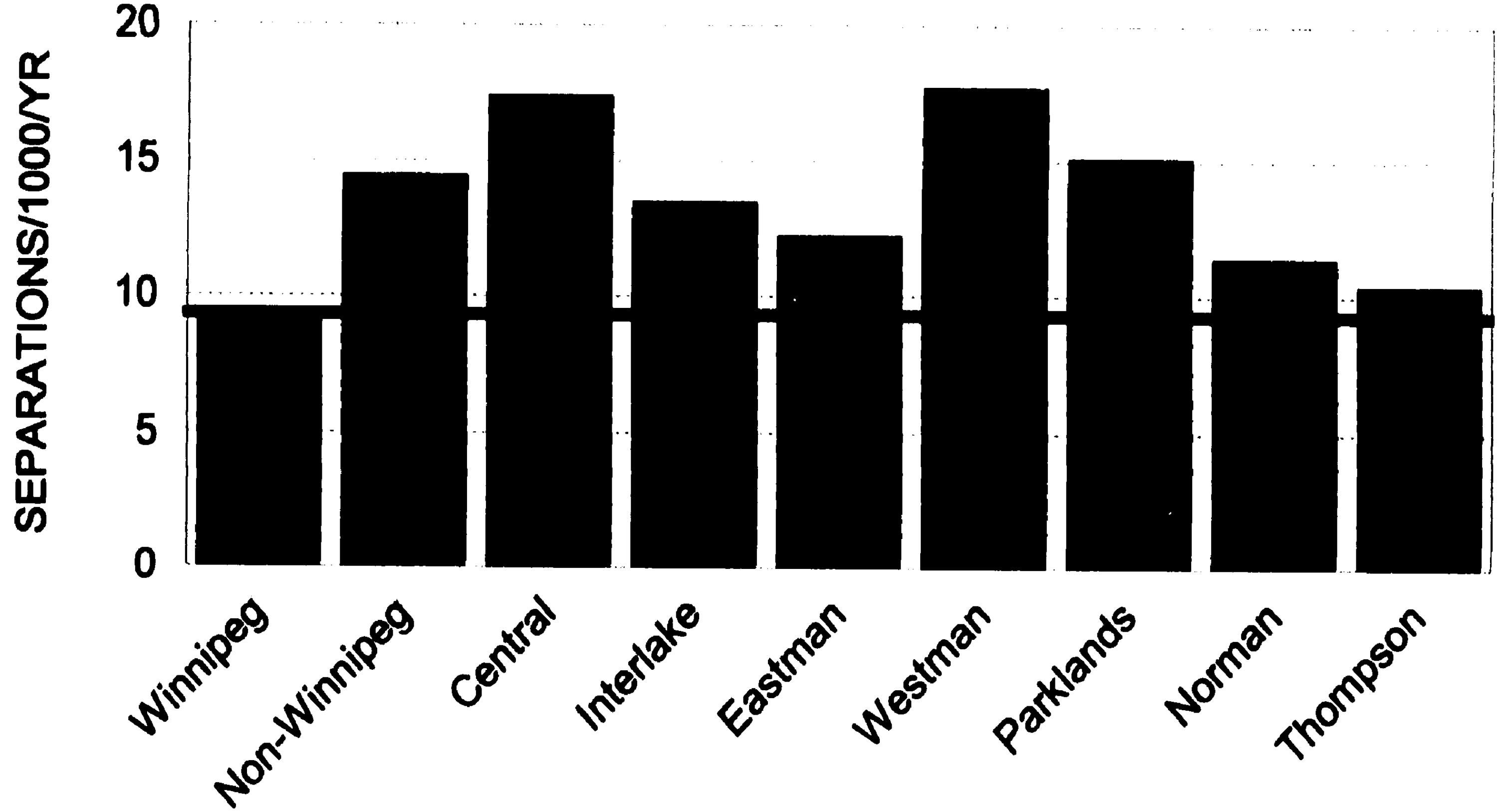


Fig.19 Manitoba Diabetes Hospitalizations 91/92
Readmissions : Non-Winnipeg vs. Winnipeg

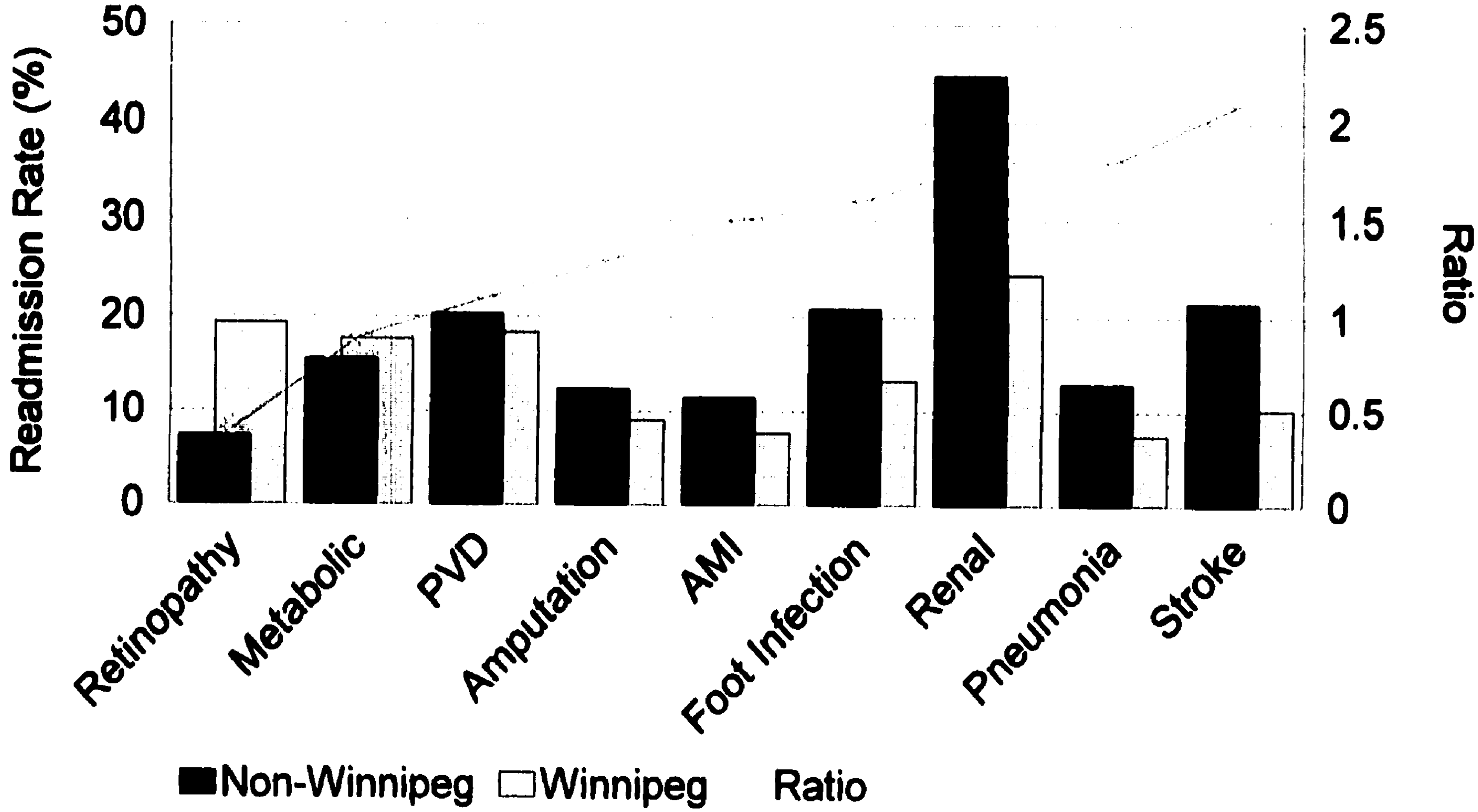


Fig.20 MANITOBA DIABETES HOSPITALIZATIONS 91/92

Winnipeg Admissions by Treaty Status

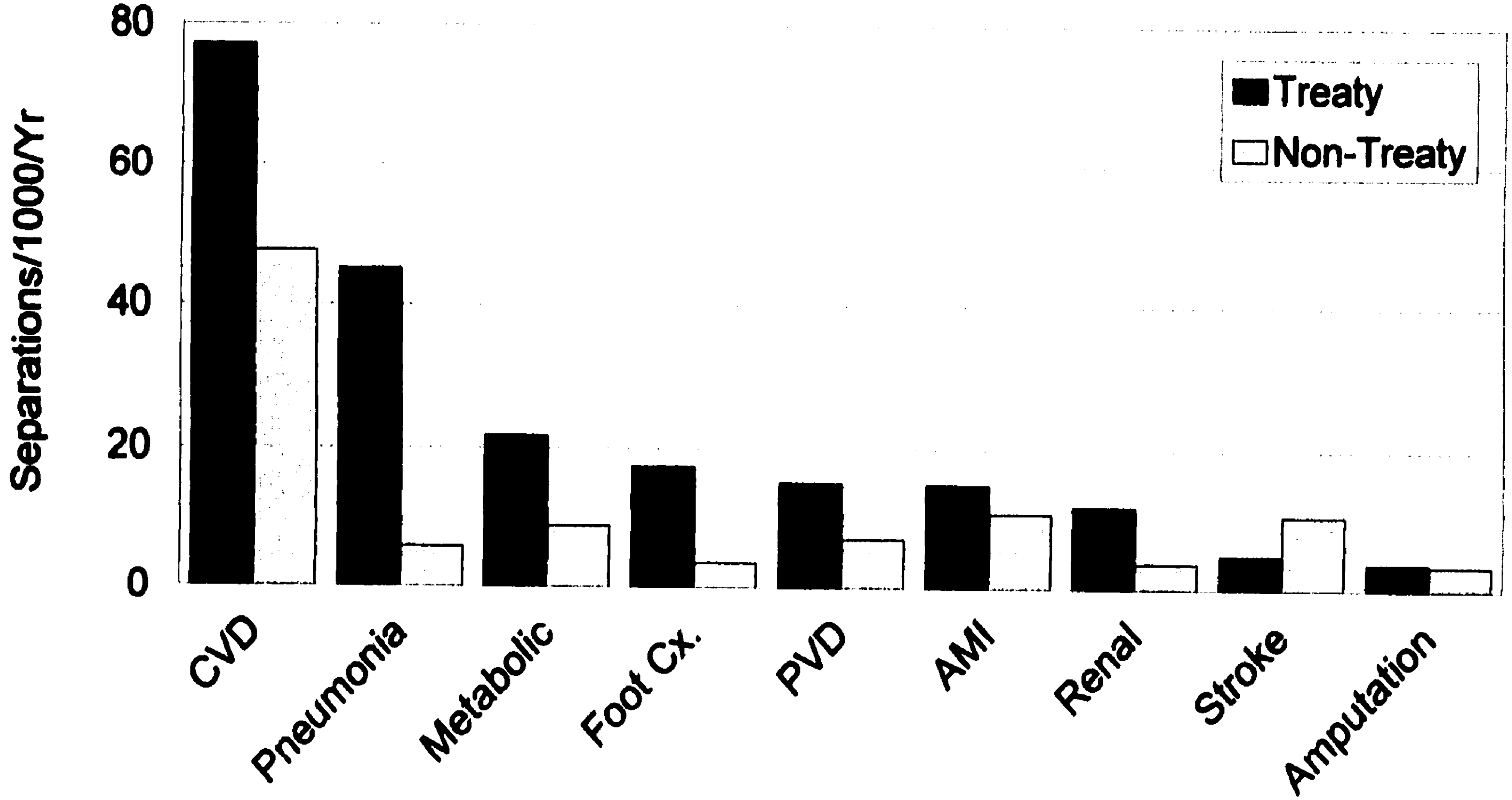


TABLE 32

MANITOBA DIABETES HOSPITALIZATIONS 1991/92 COMPLICATIONS BY TREATY STATUS - WINNIPEG

HOSPITAL ADMISSIONS (SEPARATIONS/1000)

Complication	Treaty	Non-Treaty	Ratio
Cardiac	77.1	47.6	1.6
Pneumonia	45.0	6.0	7.5
Metabolic	21.8	9.0	2.4
Foot	17.5	3.7	4.7
Peripheral Vascular	15.2	7.2	2.1
Acute Myocardial Infarction	15.0	11.0	1.4
Renal	12.0	3.9	3.1
Stroke	5.0	10.8	0.5
Amputation	3.9	3.6	1.1

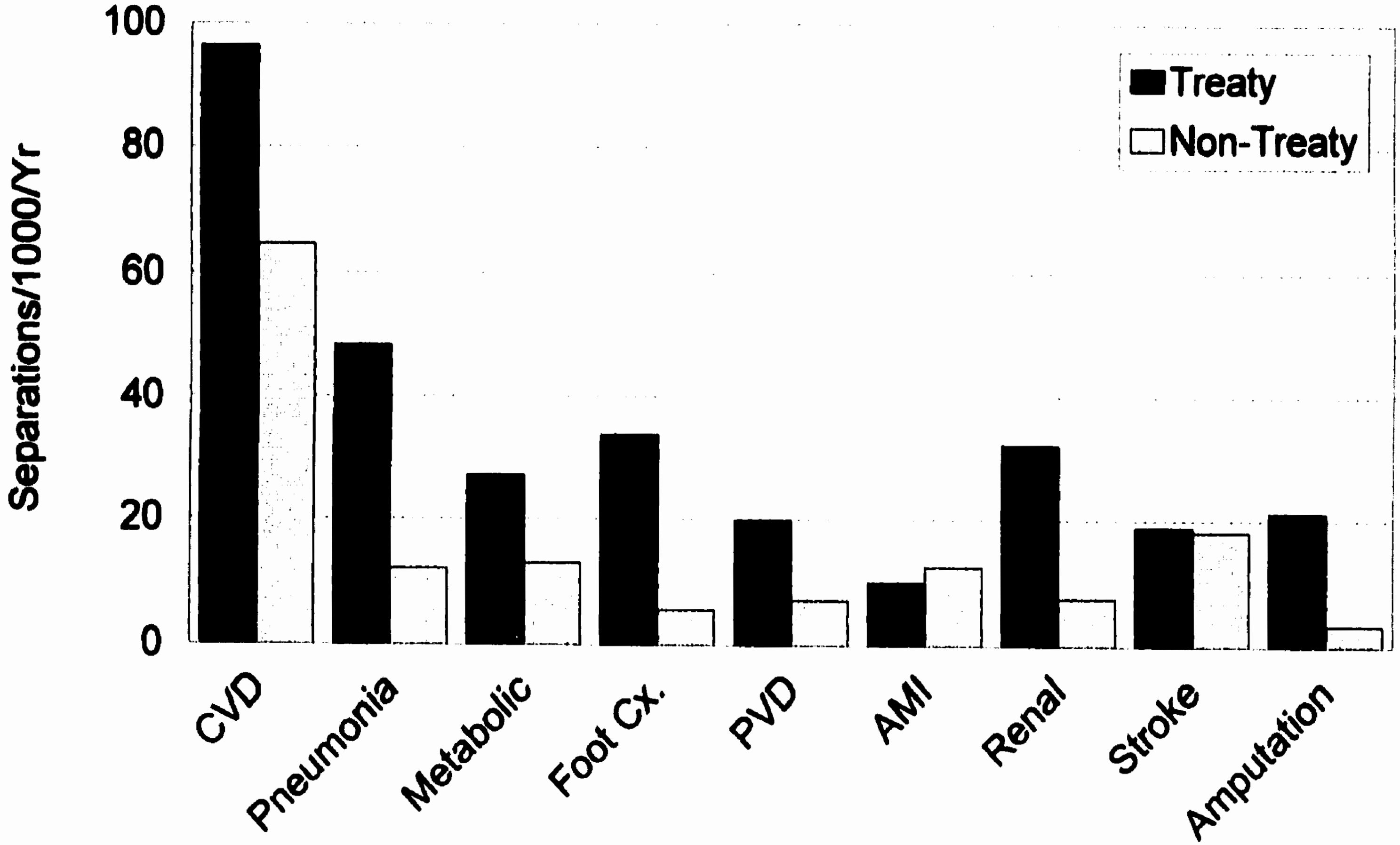
TABLE 33

MANITOBA DIABETES HOSPITALIZATIONS 1991/92 COMPLICATIONS BY TREATY STATUS - NON-WINNIPEG

HOSPITAL ADMISSION (SEPARATIONS/1000)

Complication	Treaty	Non-Treaty	Ratio
Cardiac	96.3	64.6	1.5
Pneumonia	48.3	12.2	4.0
Metabolic	27.0	13.1	2.1
Foot	33.6	5.6	6.0
Peripheral Vascular	19.8	7.1	2.8
Acute Myocardial Infarction	10.0	12.5	0.8
Renal	32.0	7.5	4.3
Stroke	18.9	18.2	1.0
Amputation	21.1	3.4	6.2

Fig.21 MANITOBA DIABETES HOSPITALIZATIONS 91/92 Non-Winnipeg Admissions by Treaty Status



6. Discussion and Conclusion

6.0 Cohort Validity

This study has demonstrated the feasibility of using administrative claims data on a province-wide basis to assess patterns of diabetes hospital utilization. The benefits of this methodology are its population-wide focus, ease of data access, the reduced time commitment required to obtain that data, affordability and the ease with which longitudinal analysis could be carried out to follow changes through time. Diabetes mellitus is particularly well suited to this form of methodologic scrutiny, as there has been a strong push for community-based service delivery and there is growing evidence that the quality of that delivery directly impacts hospital utilization. Hence, a quick, reliable and cost-effective means of monitoring hospital utilization over time has great potential for guiding the focus of community based programs and following the impact of these programs over time.

A key factor to the success of population based analyses using databases, is the validity of the data. The Manitoba Health database has been validated for numerous medical conditions and has shown particular validity for procedure based ICD9 codes, particularly surgical procedures.[117-121] Although diabetes mellitus represents a medical code, the use of the Manitoba health database to define cohorts of diabetics has now been validated in four different studies which have provided convincing figures for the prevalence and incidence of Type I or Type II diabetes mellitus in the province of Manitoba.[4-7] The case definition of diabetes for this study was similar to that used by Young, where one or more contacts, either as an outpatient or in-patient, were satisfactory for case definition. The use of hospital files alone, although quite valid, would significantly underestimate the diabetic cohort, as Young demonstrated that 95% of diabetics utilized some outpatient service during a five year period while only 43% used a hospital service.

The diabetes database developed by Blanchard used a ten year search through Manitoba health insurance records, which provided a larger case ascertainment rate. As a single medical contact for diabetes during this long time frame probably held reduced validity, the author chose to exclude any persons having only one outpatient contact with a diabetes diagnosis.

The size of the prevalent diabetes cohort selected in this study (45,117) approached that of Blanchard (47,890). More importantly, measurement of rates of hospital utilization using more conservative definitions of diabetes revealed progressively higher levels of hospital utilization. This likely represented the fact that a conservative definition of diabetes tended to define persons with more advanced disease and greater contact with the health care system, and would have biased the sample accordingly. In contrast the less conservative case definition for diabetes, used to define the cohort in this study, would tend to underestimate utilization compared to more conservative case definitions. Despite this, a marked excess utilization in the diabetic population (as compared to the non-diabetic population) was still demonstrated, and these trends were similar to those obtained from other population based studies. The influence of diabetes prevalence (particularly unascertained cases) on health care utilization has been recently reviewed by Currie.[127] The author noted that higher estimates of prevalence had little influence on the calculation of overall resource use for diabetes, as the majority of costs were related to "fixed hospital activity" for known diabetics. Hospital utilization by people with unascertained diabetes was felt to cost little by comparison to the ascertained group.

6.1 General Impact of Diabetes on Hospital Utilization

The global comparisons of rates of hospital care for diabetics and non-diabetics in this study are similar to previous findings from the UK and North America, which have shown a doubling of hospital utilization using standardized comparisons.[10,12,128] The diabetic population, while representing 5% of the total population, accounted for 10% of hospital resource utilization. This excess utilization was identical-whether hospital use was measured as separations per thousand or as use of hospital beds (hospital days per thousand). Furthermore, readmission rates, (defined as >1 hospital separation per year), were increased three fold in the diabetic cohort and the average length of stay was increased by 60% (the average length of stay for a diabetic in Manitoba was 13 days versus 8 days for non-diabetics).

This excess hospital utilization remained consistent whether for short or long stay care, although the greatest relative excess use by diabetics was for hospital stays of one week or less. This excess use of relatively short hospital stays (790.8 hospital days per thousand versus 321.3 hospital days per thousand for non-diabetics) likely reflects less significant admitting diagnoses and may be modifiable through better service delivery in the community. Although the use of long stay beds by diabetics was somewhat less on a relative basis in comparison to non-diabetics, long stay care did represent the greatest proportion of hospital days at 886.3 per thousand (32% of total hospital days). The comorbidity which most clearly contributed to long stay bed use was related to extremity complications. That these disastrous complications can be prevented by simple and inexpensive out-patient interventions has been overwhelmingly demonstrated over the past 15 years by studies from around the world.[60,61,63]

The impression that persons with diabetes receive more care in tertiary teaching hospitals compared to non-diabetics was confirmed by this study. This is an expected and appropriate response by the health care system to the highly specialized and problematical health problems experienced by this complication-prone population.

The excess hospital utilization experienced by the diabetic cohort could clearly have been secondary to the increased complexity of care in this population or by the inherent variability commensurate with the decision to admit persons with diabetes to hospital. However, stratifying hospital utilization by level of complexity, while demonstrating that diabetics in general require more complex care, also revealed a persistent excess of hospital utilization for all strata of complexity. This remained true whether stratifying admissions according to the discretionary nature of admission or by intensity of care required. This two-fold or greater hospital utilization was not related to medical admissions alone, as similar excesses of surgical bed use, psychiatric care, obstetric and pediatric in-patient hospitalization were demonstrated. Hence, the immense impact of diabetes mellitus on hospital utilization pervades all aspects of health care. A stated goal of the Canadian Diabetes Association is to bring this excess utilization towards that of the general population and the data here would suggest that there is significant work which needs to be done.[113]

6.2 Geographic Variation

The Population Health Information System hospital module has previously demonstrated an increase in short stay hospitalization rates for residents living outside Winnipeg. Winnipeg and non-Winnipeg comparisons were analyzed keeping this association in mind and were specifically reviewed because of potential disparity in the delivery of diabetes care in the two regions. In the city of Winnipeg there is close access to tertiary university teaching hospital care and a highly developed hospital-based as well as community-based diabetes education resource. Highly specialized tertiary care is not available outside Winnipeg and while diabetes education resource centers are available, many persons with diabetes are not managed at these centers. In keeping with the known patterns of hospitalization between Winnipeg and non-Winnipeg regions, (where there is a smaller likelihood that a resident of Winnipeg will be hospitalized) lengths of stay were significantly greater within the city and separation rates were lower. However, the greater than two fold excess of diabetic hospital utilization demonstrated for the province as a whole likewise remained consistent within the jurisdiction of Winnipeg as well as for non-Winnipeg regions. Subsequent analysis within the diabetic population itself (where the standard population was the diabetes cohort rather than the total Manitoba population) also demonstrated that diabetics living outside Winnipeg had a 50% excess hospital utilization compared to those living within Winnipeg. However, significant excess utilization was also demonstrated for the non-diabetic population in non-Winnipeg regions.

6.3 Disease Specific Admissions

The relative excess risk for hospital admission for recognized complications between diabetics and non-diabetics was of great interest. The relative risk of amputation at 12.9 represents the highest disease specific relative admission risk and this figure is the same as that found in other population based studies which have measured the relative risk at between 10 to 16 times that of the non-diabetic population.[50-60] The finding of a similarly high relative risk for eye disease would be expected, as a diagnosis indicative of retinal disease would have a diabetic bias because of the unique importance of diabetic retinopathy as the leading cause of blindness in North America.[40] The profound impact of microvascular pathology with diabetes is manifested not only by retinopathy but also by nephropathy with diabetes being the single leading cause of end-stage renal disease in North America. In keeping with this, the relative risk of hospitalization for renal disease (excluding outpatient dialysis visits) was identical to that of retinopathy at 10 times that of the non-diabetic population. The high relative risk for peripheral vascular disease and foot infection is expected as these are the major risk factors for amputation, for which diabetics are at extreme risk. The excess risk of stroke and acute MI, at greater than twice that of the non-diabetic population, has been previously described and this data correlates well with these studies.[68-72,76] The increased relative risk for pneumonia admission was approximately twice that of the non-diabetic population. While excess pneumonia risk has been described for diabetes, this risk had not been previously measured on a population-wide basis, and confirms an association suggested in smaller studies.[82]

Review of re-admission rates between diabetics and non-diabetics was surprisingly uniform except for conditions related to extremity complications, such as amputation, peripheral vascular disease and limb angiography, where readmission rates were 3 to 6 times those of the non-diabetic population. This is probably related to the unique pattern of peripheral vascular disease in diabetics, which is more diffuse, symmetrical and infrapopliteal in distribution compared to non-diabetics with vascular disease. The unilateral, unisegemental pattern of peripheral vascular disease in non-diabetics likely accounted for their reduced risk for readmission for revascularization, angiography or amputation of a second limb. This conspicuous finding is compatible with previous studies which have demonstrated that 30% of diabetics require amputation of the remaining limb at 3 years and 50% at 5 years.[60] This represents a tragic outcome in terms of personal costs, as bilateral limb amputation is associated with marked impairment in quality of life. It is impossible to discern from this data whether reamputations were on the same limb or the remaining limb. Amputation also poses a significant mortality threat, as diabetic amputees have a three year survival rate of approximately 50%.[59]

6.4 Age Gender Specific Mortality Rates

This analysis revealed that diabetes imposes an excess mortality risk between the ages of 25 and 74 for males and females alike. These findings again confirm previous studies which have shown that mortality rates are not increased for diabetic persons of age 75 and greater.[92-94]

There are few explanations for this paradoxical finding. It would suggest that either mild diabetes late in life has a survival advantage, or that this represents a particularly hardy cohort, who survive despite diabetes because of other genes conferring enhanced longevity. In effect, those within the diabetic cohort who lack these genes, succumb to diabetes complications. It is also important to note that the age specific mortality rates for diabetic females were similar to that of non-diabetic males. This suggested that the well documented survival advantage of female gender is negated by a diabetes diagnosis. Analysis of standardized premature diabetes mortality expressed as average premature deaths per annum per thousand also demonstrated a two fold excess premature mortality risk. This finding correlated well with the age specific mortality observations. Interestingly, excess premature mortality risk did not vary between Winnipeg and non-Winnipeg regions, despite the fact that subsequent analyses demonstrated greater complications for diabetics living outside Winnipeg. This finding is possibly related to the excess diabetes morbidity in core area Winnipeg, which has the highest complication rates and premature mortality in the province.

6.5 Influence of Treaty Status on Diabetes Hospitalization

As expected, an excess hospitalization risk was found for persons of treaty status, for whom 15% of hospitalizations were in persons with diabetes versus 10% for the non-treaty population. Further analysis of hospitalization rates revealed that 76% of treaty status diabetics were hospitalized during the study year compared to 57% of the non-treaty population, suggesting that the excess hospitalization risk for persons of treaty status was not simply related to the increased prevalence of diabetes in this population. Stratification of hospital utilization between diabetics and non-diabetics according to treaty status revealed a persistent excess risk of hospitalization across all categories. Although the excess risk of hospitalization was uniform between diabetics and non-diabetics, regardless of treaty status, the overall excess hospital utilization within the treaty status population (both diabetic and non-diabetic) was increased at least two fold over the non-treaty population. These findings indicate that diabetes exerts a similar relative impact on hospital utilization, independent of treaty status, thus further increasing hospital use in a population already highly vulnerable to hospitalization. Although diabetes imposed a similar excess relative risk of hospital utilization regardless of treaty status, the relative impact of diabetes showed greater differences between natives and non-natives living outside Winnipeg. For non-Winnipeg populations treaty status diabetics (compared to non-treaty status diabetics) exhibited an increased relative use of long-stay care, increased use of urban community hospitals, increased use of very high intensity care, marked increased obstetric care and reduced use of pediatric care. It was also interesting to note that for Winnipeg and non-Winnipeg populations, there was both a relative and absolute lower use of psychiatric beds compared to non-treaty residents. This is a highly significant finding, considering the increased hospital utilization by persons with treaty status for almost every other aspect of hospital care and may indicate under utilization of psychiatric services. The fact that treaty status did not increase the relative risk for diabetic hospitalizations for the pediatric population may be partly related to the much lower prevalence of Type I diabetes in the Aboriginal pediatric population, (where Type I diabetes is rare, and until recently, Type II diabetes seldom seen).

6.6 Diabetes Hospital Utilization: Intra-population Patterns of Use

6.6.0 Cardiovascular Disease

This study revealed a marked use of hospital days for cardiac complications. This excess of cardiac admissions remained present whether it appeared anywhere on the discharge abstract or whether it was listed as the primary diagnosis. When measuring medical admissions by primary diagnosis only, it was present at least four times as much as any other discharge diagnosis. This is of particular importance in the current era, where dramatic improvements have been made both in the primary and secondary prevention of cardiac complications in diabetes. The Scandinavian Simvastatin Survival study, which measured the influence of cholesterol lowering therapy on cardiovascular mortality, revealed that diabetic patients derived relatively greater benefits from simvastatin therapy as compared to non-diabetic patients.[129] The prevention of one coronary event in this study required that five diabetic patients be treated for five years, while in the non-diabetic population ten patients would have had to have been treated for five years to prevent a single event. This study also revealed that patients treated with this drug experienced 34% fewer days in hospital, which is of particular pertinence when considering the marked excess of cardiovascular admissions in this study. There is also clear evidence that secondary preventive efforts in patients with ischemic heart disease are suboptimal. Recent data has shown that only 10 to 20% of coronary bypass patients are receiving lipid lowering therapy.[130,131]

The impact of cardiovascular disease in diabetics was further characterized by the extreme readmission rate in this group. Once admitted during the year, diabetics in this study had a greater than 30% chance of being readmitted with a primary cardiovascular diagnosis during the study year.

Non-Winnipeg residents had a 40% excess risk of admission for cardiovascular disease, including the subgroup with acute MI. While there are generally increased admission rates for persons living outside Winnipeg, there was an extreme excess of acute myocardial infarction admissions for the Norman region, at over twice that of the provincial rate. This excess hospitalization cannot be explained on the basis of Aboriginal status alone, as the greatest proportion of Status Indians are from the Thompson Region. The excess risk in Norman is likely related to a combination of environmental risk factors such as cholesterol intake and nicotine use. The prevalence of acute MI was actually lowest in the Thompson Region, further supporting the fact that Aboriginal status did not confer an excess relative risk of coronary disease. This point has been noted in epidemiologic studies from the United States which have shown that retinopathy, nephropathy and limb complications are increased in Aboriginal diabetics, while ischemic heart disease is relatively less common.[101] The analysis of disease-specific admissions by Aboriginal status further confirmed this, showing that persons of treaty status from non-Winnipeg locations had lower admissions for acute MI compared to persons of non-treaty status.

6.6.1 Stroke

Stroke represented the second most prevalent disease specific admission category studied. It was 3 times as common in the diabetic population than it was in non-diabetics, with a 17% readmission rate. This is similar to previous data, some of which has estimated a four fold excess risk of stroke in the diabetic population. One study has shown that 15% of the economic burden of stroke is related to diabetes, with an estimate that greater than 90% of this diabetes related expenditure is potentially avoidable.[75] Persons living outside Winnipeg had a 70% greater risk of admission for this diagnosis compared to Winnipeg residents. The readmission rate was even greater for persons living outside Winnipeg, where they were twice as likely to be readmitted with a stroke diagnosis compared to a diabetic living in Winnipeg. The excess readmission rate for non-Winnipeg regions cannot be explained by this study, but may be related to lack of rehabilitation services, particularly day hospital rehabilitation for non-Winnipeg regions. It would also be important to determine whether this represented new episodes of stroke, in which case significant improvement in stroke prophylaxis would be indicated for non-Winnipeg regions. The excess hospitalization for stroke outside Winnipeg was uniformly increased in all regions except Thompson where the stroke risk was similar to that of Winnipeg. This again may represent the fact that stroke risk, like coronary disease may not be as increased in aboriginal populations with diabetes. This was particularly supported by the analysis of Winnipeg admissions by treaty status, where persons of treaty status had a reduced stroke admission rate.

6.6.2 Extremity Complications

Diabetic foot infection and amputations represented the disease category with the single greatest relative risk of admission compared to non-diabetic persons in Manitoba, where the relative risk of amputation was 12.9. Foot infection was grossly underestimated when only admissions where it was listed as the primary diagnosis were used, indicating that it was a common comorbidity for persons admitted with other primary problems. Measuring extremity complications in terms of separations per thousand also grossly underestimated the impact of hospital utilization, as these conditions represented the conditions with the longest length of stay, where amputation was associated with a 66.5 day average length of stay.

If all extremity complications (foot ulceration, peripheral vascular disease and amputation) had been combined, their impact likely would have approached that of cardiovascular disease in terms of total bed utilization. Foot complications also were associated with high readmission rates ranging from 10 to 18%. The fact that 10.6% of persons with an amputation were readmitted for another amputation procedure in the same year is highly significant; the comparisons between diabetics and non-diabetics clearly revealed that the excess readmission rate for amputation seen in the diabetic population was unique, and was not seen in the non-diabetic cohort. The excess admission rate for foot complications was increased for non-Winnipeg residents, where foot infection admissions were two fold greater compared to Winnipeg residents. The excess risk of foot infection and ulceration was grossly elevated in the two northern regions, and in Thompson this excess hospitalization was increased six times over that in Winnipeg. Part of this was related to the increased readmission rates in these regions but may have also been related to poor access to appropriate modalities of prevention. There is now a wealth of information indicating that at least 70% of these complications can be prevented.[13,60,61] Education alone has been shown to reduce the risk of foot ulceration by at least 60%.[132,133] This would suggest that the huge increase in foot infection seen in Norman and Thompson could be reduced well below current levels.

Thompson had the highest amputation rate at greater than 10 per thousand persons with diabetes compared to Winnipeg at less than 5. It is well known that foot infection and ulceration is a primary risk factor for leg amputation and Norman and Thompson in fact had the highest rates of foot infection in the province. It has also been documented that appropriate angiography and bypass procedures can reduce the rate of limb loss.[61] The ratio of foot disease to bypass procedure should therefore correlate fairly well with amputation rates and in fact this ratio was highest for the Norman and Thompson regions, where the highest amputation rates occurred. It is noteworthy that although all disease specific admissions were more common for diabetics living outside Winnipeg, angiography and bypass procedures were present at levels at or below those in Winnipeg. Therefore, the current pattern in Manitoba would suggest that persons with the greatest risk for limb amputation in the northern regions of Manitoba are receiving relatively lower rates of limb saving surgical bypass surgery. This is particularly pertinent when one considers the excess peripheral vascular disease, foot ulceration and foot infection in these regions. This finding would suggest the extreme importance of a cost-effective education initiative for patients and physicians in order to reduce these preventable complications. A profound amputation risk for persons of treaty status living outside Winnipeg was demonstrated, where the rate of amputation was increased six times over that of persons of non-treaty status. The excess burden of amputation within this population clearly requires urgent intervention.

6.6.3 Renal Complications

The admission rate for renal complications was increased ten fold in the diabetic population compared to non-diabetics, and diabetics also tended to have a far higher readmission rate for renal conditions. When measured as hospital days per thousand, it accounted for the fourth highest number of hospital days (when the diagnosis was listed in any position on the discharge abstract). However, renal disease was the primary admitting diagnosis only in about 1/3 of persons admitted with the condition. Although most dialysis admissions were listed as out-patient visits and therefore not identified on hospital discharge abstracts, renal complications still accounted for the highest rate of readmission within the diabetic population, with a readmission rate of 38% per year.

Renal complications also accounted for the greatest number of excess hospitalizations for non-Winnipeg residents who had admission rates 2.5 times that of Winnipeg residents. This excess risk was noted for all regions except for Eastman (which is in close proximity to Winnipeg) and was most marked for those regions farthest from Winnipeg, Norman and Thompson. Readmission rates were also more marked in non-Winnipeg regions, where the readmission rate was greater than 40% during a one year period. The excess admission rate for renal complications in Thompson may well be related to the excess risk for renal disease seen in persons of treaty status where the admission rate for renal complications was increased four fold. This marked excess in hospital utilization for renal complications outside Winnipeg is unlikely to be explained on the basis of practice pattern alone. It has been well established previously that rural residents use more short stay hospital days for less complex medical conditions and less illness severity in comparison to Winnipeg residents.[122] Rural residents on average used 65% greater hospital days for medical care compared to Winnipeg residents. However, the excess use of hospital days for diabetic patients with renal disease living outside Winnipeg far exceeds this bench mark, and may highlight the need to improve both the primary and secondary prevention of renal complications in person with diabetes. For example, there is now clear evidence for Type I diabetes that improvement in glycemic control can significantly reduce the development of diabetic nephropathy while use of angiotensin converting enzyme inhibitors and an improvement in blood pressure control has the same positive influence in both persons with Type I and Type II diabetes mellitus.[34,35]

6.6.4 Metabolic Complications

Metabolic complications are of interest as they represent a gross estimate of acute mishaps related to poor glycemic control, while most of the other complications of diabetes measured in this study were related to long term glycemic control. These complications were more likely to be a primary discharge diagnosis compared to other disease specific admissions but also had a fairly high one year readmission rate at slightly greater than 15% of admissions. Admissions for metabolic complications were 60% more likely for residents living outside of Winnipeg and were most prominent in central and western parts of the province. The excess hospitalization for metabolic complications was most apparent in Westman but the explanation for this is not apparent. The lack of excess hospitalization for metabolic complications for persons from Thompson is somewhat surprising, as persons of treaty status were more than twice as likely to experience an admission for metabolic complications, either hypoglycemia or hyperglycemia. This may be due to the fact that metabolic complications in the far north are attended to in a non-hospital environment or possibly are less likely to be coded as a primary discharge diagnosis. Although there was a 60% excess in rural admissions for metabolic complications, this excess may be related more to admitting practice patterns than to inferior glycemic control in rural regions. There is little data from Manitoba indicating whether diabetic control varies much between rural and urban centers. Such information would be of great advantage, particularly as metabolic complications severe enough to require hospitalization may well be life threatening.

6.6.5 Pneumonia

There is limited population-based data on the impact of diabetes on pneumonia risk. This study clearly indicates that diabetics are twice as likely to be admitted with pneumonia and that this diagnosis was often the primary diagnosis. Again, this diagnosis is associated with a gross excess in hospitalization for non-Winnipeg diabetics who were 2.3 times as likely to be admitted with this diagnosis. This excess hospitalization risk also is clearly outside the range expected for rural regions. While foot infection was the most common infectious complication attributed to diabetes, the admission rate for pneumonia in diabetics was almost twice that of foot infection. However, as the average length of stay for foot infection was almost twice that for pneumonia, the total bed use was greater for foot disease. The regions showing extreme excess risk for this diagnosis again are Thompson and Norman, the former having a 7.6 times increased separation rate for this diagnosis compared to Winnipeg. For Thompson, this partly reflects the increased incidence of pneumonia in persons of treaty status, where the risk of pneumonia was 4 to 7 times greater than that of the non-treaty population in this study. This may not explain the excess risk of pneumonia in Norman, which has proportionately fewer persons of treaty status than Thompson. It is possible that other important risk factors for pneumonia act synergistically with diabetes (smoking, chronic obstructive lung disease, poor nutrition, alcoholism and over crowding).

6.6.6 Peripheral Vascular Disease

Peripheral vascular disease was increased seven fold in persons with diabetes in this study, contributing to the marked excess risk of amputation in this population. The impact of diabetes on peripheral vascular disease has likely been underestimated previously, and is becoming more prominent as further declines in non-diabetic vascular disease have become apparent over the past few decades, possibly related to reduced rates of smoking and improvements in diet. Diabetics are more likely to be readmitted with a primary diagnosis of vascular disease compared to non-diabetics, and again this is probably related to the unique nature of peripheral vascular disease in these patients. Unlike non-diabetics, this disease tends to be more diffuse, multisegmental, symmetrical and involving smaller arteries in an infra-popliteal distribution, making peripheral bypass of greater technical difficulty. The more malignant nature of peripheral vascular disease in diabetics also likely accounts for its significant readmission rate, which in this study approximated 20% and was associated with a length of stay of 36 days and therefore a huge proportion of hospital days. This was one of the few diagnoses which did not show an excess overall rate of hospital utilization for non-Winnipeg regions, although there did appear to be some increased morbidity for Norman and Thompson. As previously mentioned, surgical bypass has been proven to reduce the morbidity associated with peripheral vascular disease, but despite the increased prevalence of peripheral vascular disease in Norman and Thompson, bypass rates did not greatly exceed those of other regions. Part of the excess risk in Thompson may be related to Aboriginal status, as persons of treaty status in this study had over twice the risk of admission with peripheral vascular disease. There has been some suggestion that use of insulin may increase the risk of this complication and there is evidence that the morbidity of peripheral vascular disease is reduced through smoking discontinuation, use of antiplatelet agents and lipid lowering therapy.[60,61] There is also evidence that education directed toward daily foot examinations and appropriate foot wear can greatly reduce the risk of foot ulceration and amputation.[132,133] Therefore, simple preventative maneuvers previously described for preventing foot complications and amputation are equally applicable to peripheral vascular disease.

6.6.7 Retinopathy

Retinopathy is exceeded only by amputation in terms of its excess relative risk compared to persons without diabetes. As a microvascular complication, claims data likely only represent a gross estimate of the impact of this complication and as such measure it in terms of persons requiring admission for complex ophthalmologic procedures or acute onset of blindness. Retinal complications, when present, are far more likely to be listed as a contributing rather than a primary diagnosis. When it appeared as a 1° diagnosis, it was associated with much shorter lengths of stay than for other diabetes related complications and accounted for a very low proportion of hospital days. Further, although almost all diabetes complications were associated with greater admission rates for persons living outside Winnipeg, admissions for ocular-related indications were identical for Winnipeg and non-Winnipeg regions, except for a modest excess hospitalization risk for persons living in Norman. Retinal complications were also the only admitting diagnosis for which Winnipeg residents were far more likely to be readmitted than persons living outside the city. This excess readmission rate in Winnipeg may in fact represent better access to specialized ophthalmologic care. "Excess" hospitalization in this setting may not be a negative finding and could represent provision of an essential medical service. The large burden of severe ophthalmologic complications which is anecdotally reported for persons living in Thompson is clearly at odds with this data, which does not show increased admission rates for retinal complications from this region. The similar rates of admission for Winnipeg and non-Winnipeg for retinal complications therefore may represent an inadequacy of service delivery rather than similar rates of disease.

6.7 Conclusions

This study has demonstrated the utility of the Manitoba Health database to profile the hospitalization experience of persons with diabetes. Few prior studies have attempted to assess diabetes hospital utilization on a population-wide basis and this is the largest study doing so in Canada. Most prior studies have used hospital discharge abstracts for diabetes case ascertainment which has been shown to underestimate the percentage of diabetes admissions by 100% and bed use by over 200%.[137] This study is unique in that it was able to use a previously validated prevalence cohort of diabetics and subsequently measure their hospital experience in a Canadian setting. Many of the findings herein are commensurate with data obtained in other countries with respect to hospital utilization rates and long-term outcomes.

6.7.1 Diabetes Prevalence and Socioeconomic Status

Use of a previously validated methodology to obtain a diabetes cohort for the province of Manitoba using claims data, identified 45,117 individuals with diabetes, representing 4.1% of the total population of Manitoba for the fiscal year 1991-92. The Canadian Diabetes Association has estimated that approximately 5% of the total

Canadian population has diabetes while the Manitoba Heart Health Study using a more rigorous definition of diabetes identified a prevalence of 6% amongst adult Manitobans.[28] The diabetes prevalence obtained from claims data is similar to prevalence estimates from other studies and represents the majority of persons recognized by the system as having a diagnosis of diabetes.[23-28] The fact that this prevalence increased with degree of social deprivation, as measured by socioeconomic status, is similar to findings from other developed countries.[102-104] This contradicts the popular misconception that diabetes is a disease of gluttony and excess and would suggest that measures to improve prevention and treatment of diabetes in this highly susceptible population may need to be further developed. The positive correlation between diabetes mellitus and social deprivation has not been explained; accounting for Treaty First Nations Status did not alter this finding.

6.7.2 Patterns of Hospital Utilization and Mortality Between Persons With and Without Diabetes

This study confirmed that despite the fact that persons with diabetes represent approximately 5% of the population they utilize 10% of hospital resources, a finding noted in other developed countries. This increased use of bed days was related to higher rates of admission, excess readmission and longer lengths of stay. This excess hospitalization was most apparent for teaching and major rural hospitals. The marked increase in readmission rates for diabetics compared to non-diabetics noted in this study, has not been previously reported, and appears to be predominantly associated with peripheral vascular and other limb threatening conditions. This would suggest that improvement in primary foot prevention practices in the community could play a major role in reducing diabetes hospital readmissions.

The increased hospital utilization noted for the diabetic cohort was observed regardless of length of stay, discretionary nature of the admitting diagnosis, the intensity or complexity of care, or whether the admission occurred in an urban or rural setting. Rather than preferentially increasing bed use amongst persons with multiple co-morbidities and complex diseases, diabetes increased bed use regardless of underlying illness severity. This suggests that significant system-wide approaches would be needed to reduce diabetes hospitalizations. This would imply that the whole population with diabetes would need to be accurately identified and adequate prevention and treatment approaches carried out on a community-wide basis; there was no subgroup of persons with diabetes identified who did not demonstrate increased bed use. Further, there were no disease-specific outcomes identified which were not increased in the diabetic population. Diabetes was associated with significant increases in the relative risk of hospitalization for most diagnoses, particularly extremity amputation, retinal disease, renal disease and foot complications. As these complications can be reduced by at least 50% with various modalities of secondary and tertiary prevention, these outcomes should be targeted for specific prevention programs.[57] This would be particularly helpful for complications with the greatest increases in relative risk, such as extremity complications, where an effective program could produce significant changes in relative hospitalization rates. Further, as cardiovascular disease, stroke and extremity complications account for most diabetes hospital bed days, efforts to manage these would provide a significant decrease in hospital bed use. Microvascular complications (retinopathy, blindness, nephropathy), while utilizing less hospital beds, entail huge personal costs and account for a significant amount of out-patient health care utilization and deserve similar focused prevention. The two-fold excess premature mortality noted within the diabetic cohort further supports the need for comprehensive community-based diabetes care.

6.7.3 Impact of Treaty Status on Patterns of Hospital Utilization for Diabetic and Non-diabetic Populations

Persons with Treaty First Nations status had the highest diabetes hospital utilization rates in the province. This highly vulnerable population exhibited both an increased prevalence of diabetes as well as an excess in diabetes complications once diabetes had developed. Although the Treaty First Nations population as a whole demonstrated higher rates of hospital utilization, a diagnosis of diabetes still increased the rate of this hospital utilization by approximately two-fold. Within the total diabetic cohort, Treaty status increased the odds of admission four-fold. For diabetic and non-diabetic comparisons, it was found that persons with Treaty status demonstrated increased use of long-stay care, greater use of urban community hospitals, higher intensity of care and greater rates of obstetric care compared to the non-Treaty population, but this was only observed outside Winnipeg. It was also noted that there was reduced utilization of psychiatric services and pediatric care by persons with Treaty status with diabetes compared to the non-Treaty population. The reduced pediatric care is undoubtedly due to the fact that Type I diabetes is rarely seen in the Aboriginal population, with Type II diabetes primarily involving older (and recently some younger) adults. The fact that there was reduced psychiatric hospital utilization cannot be explained by this study. The rate of utilization for almost all other hospital services was increased for Aboriginal diabetics, thus decreased psychiatric admissions likely represented under utilization of psychiatric services rather than reduced psychiatric illness.

6.7.4 Hospital Utilization for Various Diabetes Complications Related to Urban Residence, Health Region and Treaty Status

Hospital utilization in general was increased outside Winnipeg regardless of diagnosis. However, it was noted that there were marked variations between Winnipeg and non-Winnipeg for various diabetes complications. Residence outside Winnipeg was associated with particularly high relative rates of admission for renal disease, pneumonia, foot infection, stroke and metabolic complications, and reduced rates of angiography. The increased renal admissions may be due to the reduced availability of specialist services in nephrology and decreased availability of large dialysis units such as are available in Winnipeg. The increased foot complications may reflect inadequate preventive foot care, inappropriate foot wear, and greater and prolonged exposures to the environment. Reduced angiography is a concern, suggesting that limited availability of preventive tertiary services may also account for some increase in extremity complications. The marked excess of pneumonia admissions was also an unexpected finding, and may be related to problems such as increased smoking, crowding and wood burning stoves, but requires further study. This dramatic influence of diabetes on pneumonia morbidity has not been previously reported on a population-wide basis.

Certain health regions were associated with particularly high and unexpected complication rates and these include excess admissions for acute myocardial infarction in the Norman region, as well as significant excesses in nephropathy, pneumonia and extremity complications in Norman and Thompson. The northern regions would therefore represent an area where primary and secondary preventive diabetes care should be enhanced. Delivery of these services would be challenging due to the sparse and wide- spread nature of the communities in these regions, issues of government health care jurisdiction (federal versus provincial) and well-documented social deprivation. All regions outside Winnipeg were associated with excess hospital utilization for metabolic control. This would imply greater need outside Winnipeg for improvements in glycemic control, as poor metabolic control has now been linked to the development of long-term diabetes complications.

The Treaty First Nation's population demonstrated excess diabetes complications compared to the non-treaty diabetic population, with significant excess morbidity for pneumonia, extremity complications, renal disease and metabolic complications. It was noted that although the treaty population had an alarming excess amputation rate outside Winnipeg, the urban population had rates similar to non-Treaty status diabetics. This may be related to the multi-disciplinary diabetic foot clinic, which is only available in Winnipeg. It was also noted that although the Treaty population experienced increased morbidity for most diabetes complications compared to those with non-Treaty status, they did not experience increased rates of acute myocardial infarction or stroke. The vulnerability of this population to microvascular (renal and retinal) end-organ damage and peripheral vascular disease has been previously documented, with prior observations of relative sparing of cardiovascular diabetic complications. The relative sparing of excess cerebrovascular events in the treaty population has not been previously reported. The excess peripheral vascular events and relative sparing of cerebrovascular and coronary events suggests that different vascular beds possess differing degrees of vulnerability, depending upon the host population with diabetes and deserves further study.

The Manitoba Health Administrative Data Base has now been established as one means of measuring diabetes prevalence and hospitalization burden. This data may be used to direct health care planning, and currently suggests that community-based diabetes care needs to be improved globally on a province-wide basis in Manitoba. It also highlights populations with higher risk (persons with reduced socio-economic status, those living outside Winnipeg, persons with Treaty First Nation status) and preventable complications with unacceptably high admissions.

This methodology could be easily utilized for yearly assessment and monitoring of the effectiveness of community-based diabetes care in the future.

Appendix A

ICD-9 Codes for diabetes outcomes.

Extremity Complications (Foot infection/ulceration)

707.1X	Ulcer lower limb
707.9X	Chronic ulcer unspecified site
707.8X	Chronic ulcer other specified site
785.4X	Gangrene unspecified site
040.0X	Gas gangrene
440.24	Atherosclerosis with gangrene
440.23	Atherosclerosis with ulceration
680.7X	Foot carbuncle
681.1X	Toe cellulitis or abscess
681.9X	Unspecified digit cellulitis or abscess
682.7X	Foot cellulitis or abscess
730.27	Foot osteomyelitis

Gangrene

785.4X	Gangrene unspecified site
040.0X	Gas gangrene
440.24	Atherosclerosis with gangrene

Foot Ulceration

707.1X	Ulcer lower limb

Amputation

84.10	Lower limb amputation, unspecified
84.11	Amputation of toe
84.12	Amputation of foot
84.13	Transmetatarsal amputation
84.14	Amputation at ankle
84.15	Below knee amputation
84.16	Knee disarticulation
84.17	Above knee amputation

*Traumatic amputation excluded by removing patients with codes 895, 896, 897.

Peripheral Vascular Disease

250.7X	Diabetes with peripheral circulatory disorder
443.81	Peripheral angiopathy classified elsewhere
440.21	Atherosclerosis of extremities with claudication
440.20	Atherosclerosis of extremities unspecified
440.22	Atherosclerosis of extremities with rest pain
440.23	Atherosclerosis of extremities with ulceration
440.29	Other extremity atherosclerosis
440.30	Bypass graft

Bypass Surgery

39.25	Aorto-ileal-femoral bypass
39.29	Other peripheral vascular bypass

Angiography

88.40	Angiography unspecified site
88.42	Angiography aorta, aortic arch
88.47	Angiography intra-abdominal arteries
88.48	Angiography femoral and other lower arteries
88.49	Angiography other specified sites

Renal Diseases

250.4X	Diabetes with renal manifestations
583.81	Nephropathy in diseases classified elsewhere
580.XX	Acute glomerulonephritis
581.XX	Nephrotic syndrome
582.XX	Chronic glomerulonephritis
585.XX	Chronic renal failure
586.XX	Uremia not otherwise specified
587.XX	Renal sclerosis unspecified
588.XX	Disorders resulting from impaired renal function
39.27	Arteriovenostomy for dialysis
39.42	Arteriovenostomy revision
39.43	Removal of arteriovenous shunt
39.95	Hemodialysis
54.98	Peritoneal dialysis
55.6X	Kidney transplant
55.53	Removal transplant kidney
55.54	Bilateral nephrectomy

Acute Renal Failure

584.XX	Acute renal failure

End Stage Renal Disease

586.XX	Uremia not otherwise specified

Dialysis

39.95	Hemodialysis
54.98	Peritoneal dialysis

Retinal Diseases

250.5X	Diabetes with ophthalmic manifestations
362.01	Background diabetic retinopathy
362.02	Proliferative diabetic retinopathy
361.XX	Retinal detachment and defects
362.XX	Retinal disorders including diabetes
363.XX	Chorioretinal disease
368.XX	Visual disturbance
369.0-369.2X	Blindness both eyes
377.XX	Disorders of optic nerve and visual pathology
14.2X	Destruction of retinal lesion
14.3-14.6	Retinal surgery, removal of surgical implant
14.7X	Vitreous surgery
14.9	Other surgery retina, vitreous, choroid

Blindness

369.0X-369.2X	Blindness both eyes

Stroke

430.X	Subarachnoid bleed
431.X	Intracerebral bleed
432.X	Intracranial bleed unspecified
433.X	Precerebral artery stenosis
434.X	Cerebral artery occlusion
435.X	Transient ischemic attack
436.X	Ill defined acute cerebrovascular disease
437.X	Other cerebrovascular disease
438.X	Late effects of cerebrovascular disease

Cardiovascular Disease

410.XX	Acute myocardial infarction
411.XX	Acute/subacute ischemic heart disease
412.XX	Old myocardial infarction
413.XX	Angina
414.XX	Chronic ischemic heart disease
428.XX	Congestive heart failure
36.XX	Operation on vessels of the heart
88.50	Angiocardiography unspecified
88.55-88.58	Coronary angiography

Acute Myocardial Infarction

410.XX	Acute myocardial infarction

Tuberculosis

10.XX	Primary pulmonary TB
11.XX	Pulmonary TB
12.XX	Other respiratory TB
13.XX	Central nervous system TB
14.XX	Gastrointestinal TB
15.XX	Bone TB
16.XX	Genitourinary TB
17.XX	TB other sites
18.XX	Miliary TB
137.XX	Late effects of TB

Sepsis

38.XX	Septicemia

Bacteremia

790.7X	Bacteremia

Herpes Zoster

053.XX	Shingles

Bacterial Pneumonia

481.XX	Pneumococcal pneumonia
482.XX	Other Bacterial pneumonia
483.XX	Other bacterial pneumonia specified
485.XX	Bronchopneumonia organism unspecified
486.XX	Pneumonia organism unspecified
487.XX	Influenza

Metabolic Complications

250.1X	Diabetic ketoacidosis (coma not mentioned)
250.2X	Diabetes with hyperosmolarity
250.3X	Diabetes with coma
251.0X	Hypoglycemic coma (diabetes excluded)
251.1X	Other specified hypoglycemia (diabetes excluded)
251.2X	Hypoglycemia unspecified (diabetes excluded)
250.8X	Diabetes with other manifestations related to glycemic control

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