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Date: September 5, 2006
EVALUATION OF A COMMUNITY-BASED INTENSIVE MULTIFACTORIAL CLINICAL INTERVENTION FOR TYPE 2 DIABETES

A Thesis Submitted to the College of Graduate Studies and Research
In Partial Fulfillment of the Requirements
For the Degree of Master of Science
In the College of Kinesiology
University of Saskatchewan
Saskatoon, Canada

By
Sonya Julie Abdulla

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ABSTRACT

**Purpose:** To examine the effectiveness of a community-based intensive multifactorial clinical intervention for patients with Type 2 diabetes, to evaluate the feasibility of achieving clinical targets for glycemic control in a community setting, and to identify factors that are predictive of glycemic control in this cohort (age, gender, disease duration, continuity of care, pharmacologic treatment, diabetes self-care and smoking status). **Methods:** Participants with Type 2 diabetes referred to the Diabetes Clinic following dissemination of the 2003 Clinical Practice Guidelines of Canadian Diabetes Association and who attended a minimum of two physician visits within a twelve month period were deemed eligible for participation. 70 patients were included in this retrospective study. Baseline and twelve month values for the following biomedical outcomes were collected via chart audit: BMI, hemoglobin A1c, blood pressure (systolic, diastolic) and lipid profile (HDL, LDL, triglycerides, total cholesterol, TC:HDL ratio). Data for identification of predictive factors for glycemic control were also retrieved by chart audit. **Results:** The results of the paired t-test yielded a significant improvement in hemoglobin A1c (p<0.05), systolic blood pressure (p<0.01), HDL-cholesterol (p<0.05), LDL-cholesterol (p<0.01), total cholesterol (p<0.05) and total cholesterol:HDL ratio (p<0.05) over twelve months. No significant difference in BMI, diastolic blood pressure or triglycerides was reported over twelve months. Over half the sample (52.9%) achieved clinical targets for glycemic control (hemoglobin A1c <7.0%) at twelve months. Logistic regression analysis identified disease duration (O.R. = 0.90, 95% CI Exp(B) = 0.079 - 0.773, p = 0.01) and continuity of care (O.R. = 0.25, 95% CI Exp(B) = 0.831 - 0.969, p = 0.02) as significant predictors of glycemic control at twelve months.
Conclusions: These findings demonstrate the effectiveness of this community-based intensive multifactorial clinical intervention for patients with Type 2 diabetes and show that the implementation of CPGs related to glycemic control is feasible in a community-based setting. Additionally, patients in this cohort with increased disease duration and increased continuity of care were less likely to achieve clinical targets for glycemic control following a twelve month intensive multifactorial clinical intervention for Type 2 diabetes. In summary, health professionals should strive to implement similar intensive multifactorial interventions in community practice in order to decrease the likelihood of diabetes-related complications and improve the patient’s quality of life.
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<tr>
<td>CDA</td>
<td>Canadian Diabetes Association</td>
</tr>
<tr>
<td>CPG</td>
<td>Clinical Practice Guideline</td>
</tr>
<tr>
<td>Hb A1c</td>
<td>Hemoglobin A1c or Glycosylated hemoglobin</td>
</tr>
<tr>
<td>LDL</td>
<td>Low density lipoprotein</td>
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<tr>
<td>HDL</td>
<td>High density lipoprotein</td>
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<tr>
<td>IDL</td>
<td>Intermediate density lipoprotein</td>
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<td>VLDL</td>
<td>Very low density lipoprotein</td>
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<tr>
<td>BMI</td>
<td>Body Mass Index</td>
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<tr>
<td>SMBG</td>
<td>Self-Monitored Blood Glucose</td>
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<tr>
<td>OHA</td>
<td>Oral Hypoglycemic Agent</td>
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CHAPTER 1

SCIENTIFIC FRAMEWORK

1.1 Introduction

In Canada, more than two and a quarter million people are currently living with Type 2 diabetes (Health Canada, 2002). Given the increasing levels of obesity in Canada and the increasing age of the Canadian population, these numbers are expected to increase over time (Health Canada, 2002). The high incidence of Type 2 diabetes is of particular concern given that approximately 40 percent of Canadians with Type 2 diabetes will develop long-term microvascular and macrovascular complications (Canadian Diabetes Association, 2003). Insulin resistance, which is characteristic of Type 2 diabetes, has been associated to a number of other health disorders including obesity, dyslipidemia and hypertension (Bogardus, 2000). Each of these health disorders are also independent risk factors for the development of cardiovascular disease (Bogardus, 2000). Knowing that over 40 percent of people with Type 2 diabetes who develop microvascular and macrovascular disease will die of some form of heart or blood vessel disease (Canadian Diabetes Association, 2003), it is imperative that appropriate interventions are developed in order to prevent the onset of these complications. Current literature suggests that most effective clinical interventions for patients with Type 2 diabetes are driven by evidence-based clinical practice guidelines (UKPDS Group, 1998; UKPDS Group, 1998)
In order to treat patients in the most efficacious manner, a group of clinical practice guidelines (CPGs) has been developed by the Canadian Diabetes Association (Canadian Diabetes Association, 2003). CPGs are a group of evidence-based statements that have been systematically developed to assist practitioner and patient decisions regarding appropriate health care for specific clinical circumstances (AACE, 2004). Although the CPGs of the Canadian Diabetes Association have been developed and endorsed by experts in the field of diabetes care, their implementation and achievement can present a challenge for physicians and patients alike (Beaulieu, Hudon, Roberge, Pineault, Forté & Légaré, 1999). Current recommendations imply that the achievement of clinical targets related to diabetes management is most likely using a multifaceted, interdisciplinary approach (Ménard, Payette, Baillargeon, Maheux, Lepage, Tessier et al., 2005).

Previous research indicates that a multifactorial approach to diabetes therapy is most appropriate when treating people with Type 2 diabetes (Gaede, Vedel, Larsen, Jensen, Parving & Pedersen, 2003). The term multifactorial implies that clinical interventions are focused on a number of risk factors for the development of microvascular and macrovascular complications including hyperglycemia, hyperlipidemia and hypertension (Gaede et al., 2003). The assessment of the effectiveness of a community-based intensive multifactorial clinical intervention is necessary to determine whether the extensive research that has been conducted in this area can be translated to community-based practice. Although these interventions have
proved successful in a controlled, research setting, their feasibility has yet to be examined in the community. Additionally, it remains unclear whether patients enrolled in a community-based multifactorial clinical intervention for Type 2 diabetes are able to achieve CPGs for glycemic control (hemoglobin A1c <7.0%) (Ménard et al., 2005; UKPDS Group, 1999). In order to improve the approach to clinical interventions in community-based settings, a better understanding of factors that predict the achievement of clinical practice guidelines is essential. The identification of factors that are predictive of glycemic control will allow health care professionals to improve the design of future clinical interventions in diabetes care and better meet the needs of their patient population. At present, the identification of these factors remains unclear (Nichols, Hillier, Javor & Betz Brown, 2000).

Therefore, the following study will examine the efficacy of a community-based intensive multifactorial clinical intervention for people with Type 2 diabetes. Efficacy will be evaluated according to improvement in biomedical outcomes over time such as glycemic control, blood pressure and lipid profile. Additionally, it will assess the feasibility of implementing the 2003 CDA CPGs for glycemic control by evaluating the number of patients who achieve clinical targets for glycated hemoglobin (<7.0%) at twelve months. Lastly, this study will examine some of the factors that are predictive of glycemic control in people with Type 2 diabetes undergoing a community-based intensive multifactorial clinical intervention.
1.2 Review of Literature

1.2.1 Incidence of Type 2 Diabetes in Canada

More than two and a quarter million Canadians are estimated to have Type 2 diabetes and more than 60,000 new cases of diabetes are diagnosed each year (Health Canada, 2002). Over the next twenty five years, the prevalence of Type 2 diabetes is expected to increase by 35% (King, Aubert & Herman, 1998). If present trends related to the increasing age of the population and rising obesity rates continue, the incidence of Type 2 diabetes in Canada will continue to increase at an exponential rate (Health Canada, 2002). Obesity and increasing age have been consistently linked to the development of insulin resistance and in turn to the development of Type 2 diabetes (Cosford, 1999). It is therefore important to address the factors underlying the development of insulin resistance and Type 2 diabetes in order to limit the onset of related health complications, particularly those of the microvascular and macrovascular type.

Of Canadians with Type 2 diabetes, approximately 40 percent will develop long-term microvascular and macrovascular complications (Canadian Diabetes Association, 2003). Microvascular complications include conditions such as retinopathy, nephropathy and neuropathy while macrovascular complications encompass any condition related to the weakening of blood vessels such as heart disease, stroke and hypertension. Diabetes and its complications account for 25,000 person years of life lost before age 75 (Health Canada, 2002). Diabetes is a contributing factor in the deaths of approximately 41,500
Canadians each year (Canadian Diabetes Association, 2003). Canadian adults with diabetes are twice as likely to die prematurely, compared to persons without diabetes (Canadian Diabetes Association, 2003). The majority of deaths in people with Type 2 diabetes are not necessarily a direct result of one's diabetic condition but likely due to diabetes related complications (UKPDS Group, 1999). These complications can often be prevented or substantially delayed however; optimal diabetes therapy is costly to the individual patient as well as the health care system (American Association of Diabetes Educators, 2002).

1.2.2 Economic Burden of Type 2 Diabetes

In addition to the health risks associated with this disease, diabetes places a considerable burden on the Canadian healthcare system. A person with diabetes incurs medical costs that are two to three times higher than that of a person without diabetes (Dawson, Blanchard, Gomes, Gersten & Kahler, 2002). Direct costs incurred by Medicare for an individual with diabetes range from $1,000 to $15,000 per year (Canadian Diabetes Association, 2003). These fees include the cost of items such as medication and supplies. In 1998, the direct costs associated with diabetes care before considering any complications were $573 million (Dawson et al., 2002). The total economic burden of diabetes and its complications was estimated to be between $4.76 and $5.23 billion per year in 1998 (Dawson et al., 2002). Today, the cost of diabetes and its complications are estimated to cost the Canadian healthcare system an estimated $13.2 billion per year (Canadian Diabetes Association, 2003). By 2010, it is estimated these
costs will rise to $15.6 billion per year and by 2020, $19.2 billion per year (Canadian Diabetes Association, 2003). Of the estimated costs associated with the complications of diabetes in Canada, cardiovascular disease was by far the greatest at $637 million - close to $100 million more than the direct costs of diabetes care (Dawson et al., 2002). Given the dramatic increase in the economic burden of diabetes and its related complications on the healthcare system, diabetes intervention strategies should aim to more efficiently manage diabetes and related complications (Dawson et al., 2002).

The current approach to diabetes care has proven successful in longitudinal RCTs as evidenced by the decreased incidence in microvascular and macrovascular complications (UKPDS Group, 1998; UKPDS Group, 1999); however, their implementation in community-based settings remains challenging. The sheer cost of medication, supplies and medical devices is sufficient to pose an obstacle to appropriate diabetes care (Canadian Diabetes Association, 2003). In Canada, the costs related to pharmacologic diabetes therapy are subsidized in part by provincial government drug coverage (Canadian Diabetes Association, 2003). However, this coverage varies greatly across the country (Canadian Diabetes Association, 2003). Some plans cover almost all costs for all the medication, supplies and devices which are needed to adequately manage diabetes, while other jurisdictions provide little or no coverage for these same items (Canadian Diabetes Association, 2003). This disparity creates a fragmented system across the country resulting in inequitable access to treatment. Although access to appropriate diabetes care is essential for all Canadians with diabetes, it is important to recognize the
limitations associated with these interventions in a community-based setting. In order to understand the underlying principles of clinical interventions for Type 2 diabetes, an understanding of the underlying pathophysiology of disease is necessary.

1.2.3 Pathophysiology of Disease

1.2.3.1 Etiology of Type 2 Diabetes

Type 2 diabetes is characterized in most subjects by insulin resistance with inadequate insulin response to maintain normal blood sugar levels (normoglycemia) (Parker, Luscombe, Noakes & Clifton, 2002). The diagnosis of Type 2 diabetes is made when the individual exhibits all of the following symptoms: hyperglycemia, insulin resistance and impaired glucose responses (Davidson, 2000). Conditions in which the individual exhibits lesser degrees of the aforementioned symptoms, the diagnosis is termed impaired fasting glucose tolerance (Davidson, 2000). These individuals are classified as pre-diabetics who may develop Type 2 diabetes if appropriate management strategies are not taken (Davidson, 2000). At the root of these metabolic abnormalities is insulin.

Insulin is the hormone required to transport glucose across the permeable cell membrane (Flakoll, Carlson & Cherrington, 2000). It is released in response to elevations in blood glucose levels, with more being released in response to foods that cause a rapid increase in blood glucose levels (high glycemic index foods) (Flakoll et al., 2000). Insulin resistance is a fundamental aspect of the etiology of Type 2 diabetes (Kahn & Flier, 2000). Type 2 diabetes is usually preceded by a long period of
asymptomatic hyperinsulinemia which in turn, leads to insulin resistance (Rosenbloom, 2003). Eventually, the pancreatic β-cell fails to compensate for the insulin resistance; a state referred to as impaired fasting glycemia (IFG) or impaired glucose tolerance (IGT). Finally, Type 2 diabetes becomes overt (Rosenbloom, 2003) and the disease will evolve as exclusive β-cell insufficiency (UKPDS Group, 1991). Thus insulin resistance and eventual β-cell failure develop over time and in turn with age (Rosenbloom, 2003). Type 2 diabetes is characterized by increasing hyperglycemia with increasing disease duration, however; this disease also leads to pathologies of other body systems (Bogardus, 2000).

The body’s inability to produce sufficient insulin will not only influence its ability to regulate hyperglycemia but will also adversely affect lipid metabolism and vascular function, possibly resulting in other health complications (Bogardus, 2000). Although insulin resistance is most commonly associated with Type 2 diabetes, poor insulin activity and chronically elevated insulin levels are also associated with a number of other health disorders such as obesity, hypertension, dyslipidemia and cardiovascular disease (Bogardus, 2000).

1.2.3.2 Insulin Resistance & Obesity

Obesity is strongly correlated with insulin resistance (Beck-Nielsen & Hother-Nielsen, 2000). Researchers have found that insulin resistance promotes obesity via insulin’s anabolic effects on fat metabolism (Beck-Nielsen & Hother-Nielsen, 2000). Insulin stimulates lipogenesis in adipocytes via increased production of acetyl-CoA
(Beck-Nielsen & Hother-Nielsen, 2000). Insulin also increases glucose uptake into adipocytes which is converted to glycerophosphate and is then synthesized into triglycerides (Beck-Nielsen & Hother-Nielsen, 2000). These processes inhibit lipoprotein lipase as well as adenylate cyclase, thus impeding fat catabolism (Beck-Nielsen & Hother-Nielsen, 2000). Given the increased synthesis of lipids and their decreased metabolism, weight gain ensues (Beck-Nielsen & Hother-Nielsen, 2000). In addition to the impaired fat catabolism, insulin resistance may also promote decreased feeding-related, insulin-mediated thermogenesis (Cosford, 1999). This decrease in metabolic rate also contributes to weight gain. This evidence suggests that increased levels of insulin resistance influence weight gain and the onset of obesity through direct and indirect metabolic pathways (Cosford, 1999). Conversely, the degree of insulin resistance one exhibits also appears to be directly related to one’s level of obesity and its distribution throughout the body (Cosford, 1999). Therefore, the distribution of one’s obesity may lead to a state of altered insulin sensitivity.

Although measures such as the body mass index (BMI) provide an overall depiction of body composition, it is critical to recognize that the distribution of one’s body fat is linked to insulin resistance (Kahn & Flier, 2000). Intra-abdominal deposits of adipose tissue are strongly linked to metabolic disorders such as insulin resistance, Type 2 diabetes and cardiovascular disease as compared to gluteal fat deposition (Beck-Nielsen & Hother-Nielsen, 2000). The exact mechanism through which central obesity contributes to the development of metabolic disorders is unclear (Kahn & Flier, 2000). It
has been suggested that an unknown common factor may produce both central obesity and insulin resistance and that central obesity may not necessarily be the cause of insulin resistance (Kahn & Flier, 2000). Alternatively, a biochemical feature of intra-abdominal adipocytes may directly influence systemic insulin sensitivity (Kahn & Flier, 2000). In order to address the possible role of adipose tissue distribution in the management of Type 2 diabetes, the present study will evaluate waist circumference among participants.

Scientific evidence indicates an undeniable association between obesity and insulin resistance (Boden, Chen, Capulong & Mozzoli, 2001). Although insulin resistance would intuitively improve with a reduction in body weight, large-scale randomized control trials have shown that patients undergoing intensive insulin therapy experience weight gain as a result of the pharmacologic treatment. In a meta-analysis conducted by Yki-Järvinen (2001), the main predictors of weight gain were initial glycemia and its response to treatment. Thus, the patient who had poor glycemic control before initiation of insulin therapy, but responded well to treatment, was at greatest risk for weight gain (Yki-Järvinen, 2001). In order to examine any potential weight change in response to the intensive multifactorial clinical intervention, the present study will evaluate body mass index (BMI) over time. In addition to its association with obesity, insulin resistance has also been identified as a risk factor for the development of other health complications, such as hypertension, dyslipidemia and cardiovascular disease (Davidson, 2000).
1.2.3.3 Insulin Resistance & Hypertension

Hypertension is defined as increased blood pressure caused by either too much fluid in the blood vessels or by narrowing of the blood vessels (Gudbjornsdottir, Lonnroth, Sverrisdottir, Wallin & Elam, 1996). In approximately 2 to 5% of people with hypertension, increased blood pressure is caused by underlying renal or adrenal disease (Gudbjornsdottir et al., 1996). In the rest of the population, no clear single identifiable cause has been identified (Gudbjornsdottir et al., 1996). Hypertension in these individuals is labeled "essential hypertension" (Gudbjornsdottir et al., 1996). A number of physiological mechanisms are involved in the maintenance of normal blood pressure, and their derangement may play a part in the development of essential hypertension and associated conditions (Gudbjornsdottir et al., 1996).

In 1923, Swedish physician Eskil Kylin described hypertension as a component of the metabolic syndrome (Nilsson & Hedblad, 2002). Since this time, hypertension has been linked to insulin resistance (Nilsson & Hedblad, 2002). Although there appears to be a higher incidence of hypertension in people with Type 2 diabetes, researchers maintain that insulin resistance is not the cause of hypertension but does contribute to its progression (Nilsson & Hedblad, 2002). Researchers have suggested that increased total body exchangeable sodium is responsible for the higher incidence of hypertension in people with Type 2 (Hall, 2000). Increases in plasma insulin appear to stimulate sodium reabsorption by the kidney in a dose-response fashion (Hall, 2000). Thus, hypertension associated with Type 2 diabetes is a result of increased blood volume (Hall, 2000).
However, insulin also appears to have an effect on vascular function in people with Type 2 diabetes (Stern & Tuck, 2000).

In addition to the effect of insulin on sodium reabsorption, increased levels of this hormone affect the sympathetic nervous system (Stern & Tuck, 2000). Insulin acts on the sympathetic nervous system to increase vascular tone and blood pressure (Stern & Tuck, 2000). Researchers have demonstrated that plasma norepinephrine increases in both animals and humans in the presence of insulin (Stern & Tuck, 2000). Additionally, insulin may also increase sympathetic discharge from the central nervous system (Stern & Tuck, 2000). Given the high prevalence of hypertension among patients with Type 2 diabetes, this study will evaluate its incidence and evaluate improvement in systolic and diastolic pressure over time among participants in this clinical intervention. As previously stated, decreased insulin sensitivity is associated to a number of metabolic abnormalities in people with Type 2 diabetes. In addition to obesity and hypertension, insulin resistance has also been linked to lipid abnormalities in people with Type 2 diabetes.

1.2.3.4 Insulin Resistance & Dyslipidemia

Dyslipidemia is another condition linked to insulin resistance that commonly occurs in people with Type 2 diabetes (Boden & Shulman, 2002). Diabetic dyslipidemia is characterized by normal or only moderately elevated LDL levels, elevated VLDL and low HDL levels (Boden & Shulman, 2002). HDL particles appear to be involved in reverse cholesterol transport, resulting in an antiatherogenic effect (Boden & Shulman,
Researchers suggest that HDL may prevent the formation of or remove cholesterol deposits within the arterial wall (Boden & Shulman, 2002). An important function of HDL is that it can serve as a marker for abnormal metabolism of chylomicrons and VLDL particles; as triglycerides increase, HDL decreases (Boden & Shulman, 2002). In people with Type 2 diabetes and dyslipidemia, the protective effects of high density lipoproteins are lost due to their low levels (Boden & Shulman, 2002). Compounded by hypertriglyceridemia, people with Type 2 diabetes and dyslipidemia are at increased risk for developing cardiovascular disease (Boudou, de Kreviler, Erlich, Vexiau & Gautier, 2001). In sum, low levels of HDL and high levels of triglycerides lead to the formation of fatty streaks on the arterial walls and the hardening of the arteries (Boden & Shulman, 2002). Given the role of diabetic dyslipidemia in the development of cardiovascular disease, it is an important parameter to address in diabetes care (Canadian Diabetes Association, 2003). Therefore, an evaluation of the lipid profile will be performed in order to detect any potential improvements in these parameters over time in patients undergoing an intensive multifactorial clinical intervention for Type 2 diabetes.

As previously stated, insulin resistance is not only responsible for the development of hyperglycemia in people with Type 2 diabetes but contributes to a number of other related pathologies (Beck-Nielsen & Hother-Nielsen, 2000; Boden et al., 2001; Boden & Shulman, 2002; Hall, 2000). Given the contribution of insulin resistance to the development of obesity, hypertension and dyslipidemia, it is essential to ensure that
the most effective clinical interventions are undertaken to control hyperglycemia as well as other associated conditions in people with Type 2 diabetes.

1.2.4 Management

1.2.4.1 Intensive Single Factor Risk Management in Type 2 Diabetes

In the past, conventional diabetes therapy in individuals with Type 2 diabetes focused primarily on single risk factor management such as achieving the absence of symptoms attributable to hyperglycemia (The DCCT Research Group, 1993). However, conventional diabetes therapy does not set specific glycemic targets and therefore, patients rarely achieve normoglycemia (fasting plasma glucose <7.0 mmol/L, glycated hemoglobin <6.5%), increasing the potential for microvascular and macrovascular complications (The DCCT Research Group, 2001). Randomized trials have examined the effect of intensive pharmacologically-driven diabetes therapy on a single risk factor (eg. hyperglycemia) in individuals with Type 2 diabetes and reported a significant reduction in both macrovascular and microvascular diabetes-related complications (UKPDS Group, 1991; UKPDS Group, 1998; UKPDS Group, 1998; UKPDS Group, 1999). These studies have shown that intensive pharmacologically-driven diabetes therapy is an approach to patient care that establishes set glycemic targets and focuses on achieving and maintaining blood glucose levels within normoglycemic values (UKPDS Group, 1998; UKPDS Group, 1998; UKPDS Group, 1999). Using this goal-oriented approach, patients with Type 2 diabetes are more likely to achieve normoglycemia via pharmacologic means.
and may thus be better able to prevent and/or manage microvascular and macrovascular complications (UKPDS Group, 1998; UKPDS Group, 1998; UKPDS Group, 1999).

The first study to report significant findings related to intensive clinical interventions in individuals with Type 2 diabetes was the United Kingdom Prospective Diabetes Study (UKPDS) (UKPDS Group, 1998). The UKPDS was developed in order to establish glycemic targets for patients with Type 2 diabetes and clarify the roles of different pharmacologic approaches to the management of hyperglycemia (UKPDS Group, 1991). The UKPDS included 3867 individuals with newly diagnosed Type 2 diabetes (54 ± 7 years, mean ± SD) who were randomized to either intensive or conventional treatments. The objective of the intensive treatment was to achieve normoglycemia through pharmacologic treatment (sulfonylurea, biguanide and/or insulin) while the conventional treatment focused on achieving the absence of hyperglycemic symptoms through diet therapy (UKPDS Group, 1998). Participants were followed for a mean duration of 10 years in order to evaluate the effect of intensive versus conventional therapy on microvascular and macrovascular complications, as well as other variables (UKPDS Group, 1998). The results of the UKPDS have helped to revolutionize the approach to clinical management of patients with Type 2 diabetes. The UKPDS provided conclusive evidence that morbidity from microvascular complications of Type 2 diabetes can be significantly reduced by intensive, target-driven glucose-lowering therapy (UKPDS Group, 1998; UKPDS Group, 1999). Intensive diabetes therapy using sulfonylureas, biguanides or insulin resulted in a 25% reduction in microvascular
complications (UKPDS Group, 1998). Moreover, for every 1% decrease in glycated hemoglobin level, the risk of microvascular complications decreased by 35%, diabetes-related death decreased by 25% and all-cause mortality decreased by 7% (UKPDS Group, 1998). Although risk reduction for macrovascular complications was observed in the UKPDS, the results were not statistically significant (UKPDS Group, 1998). The results of the UKPDS glucose control trials emphasize the importance of achieving normoglycemia in people with Type 2 diabetes in order to prevent microvascular complications and refute the implementation of previous conventional therapy related to glycemic control.

The UKPDS Group also conducted a secondary study examining the effect of blood pressure control on microvascular and macrovascular complications (UKPDS Group, 1999). Participants in the Hypertension in Diabetes sub-study (n = 1148) were also involved in the glucose control portion of the UKPDS (n = 3867). Participants were randomized to either conventional antihypertensive therapy (target blood pressure \(<180/105\) or intensive antihypertensive therapy (target blood pressure \(<150/85\) mm Hg). Randomization to either conventional or intensive hypertensive therapy was done independently of the randomization in the glucose control portion of the UKPDS. One or more antihypertensive pharmaceuticals were used to achieve target blood pressures in both the conventional and intensive antihypertensive therapy groups. The Hypertension in Diabetes sub-study of the UKPDS confirmed the importance of intensive blood pressure control on a range of microvascular and macrovascular complications (UKPDS
Group, 1999). The findings of the sub-study yielded a 37% reduction in microvascular disease and 44% reduction in macrovascular disease in individuals with Type 2 diabetes, independent of the antihypertensive pharmaceutical agent used to achieve blood pressure control (UKPDS Group, 1999). Thus, the findings of the UKPDS present compelling evidence for health professionals and patients to aim for tighter glycemic and blood pressure control via pharmacologic means in order to potentially reduce the incidence of microvascular and macrovascular diabetes-related complications in people with Type 2 diabetes. Given this evidence, hemoglobin A1c and blood pressure levels will be two outcomes used to evaluate the efficacy of the community-based diabetes intervention in this study. However, the impact of other factors such as dyslipidemia must also be recognized.

The management of hyperglycemia in people with Type 2 diabetes is an integral part of diabetes care however; the contribution of factors such as hypertension and dyslipidemia to the development of microvascular and macrovascular complications is well recognized and should also be considered when implementing diabetes management interventions (Boden & Shulman, 2002). Therefore, diabetes management interventions should adopt an approach to treatment that targets multiple risk factors such as hyperglycemia, hypertension and dyslipidemia in order to prevent or decrease the incidence of microvascular and macrovascular complications (Gaede, Vedel, Larsen, Jensen, Parving & Pedersen, 2003). This approach to diabetes therapy has been deemed
“multifactorial”. A review of current findings related to intensive multifactorial clinical interventions, such as the one that will be examined in this study, follows.

1.2.4.2 Multifactorial Clinical Interventions in Type 2 Diabetes

The term multifactorial implies that diabetes care is focused on achieving biomedical targets for multiple risk factors for microvascular and macrovascular complications, primarily, glycemic control, hypertension and dyslipidemia (Canadian Diabetes Association, 2003). Multifactorial interventions combine pharmacologic therapy (insulin, oral hypoglycemic agent(s)) and behaviour modification (diet, physical activity) in order to achieve biomedical targets (Canadian Diabetes Association, 2003).

The additive benefits of multiple risk factor management (hyperglycemia, hypertension, dyslipidemia) for microvascular and macrovascular complications in Type 2 diabetes were recently assessed by a group of Danish researchers (Gaede et al., 2003). Gaede et al. (2003) examined the effectiveness of a multifactorial clinical intervention on cardiovascular disease risk factors in people with Type 2 diabetes and examined the feasibility of achieving clinical targets for glycemic control, blood pressure and lipid profile. Gaede et al. (2003) compared the effect of an intensive multifactorial cardiovascular disease risk management program on physiological outcomes (hyperglycemia, hypertension, dyslipidemia) in a group of participants with Type 2 diabetes versus the conventional multifactorial clinical intervention recommended by the Danish national guidelines. The multifactorial intervention focused on achieving specific biomedical targets (HbA1c <6.5%, blood pressure <140/85 mm Hg, total cholesterol <
190 mg/dl (4.92 mmol/L), triglycerides < 150 mg/dl (1.70 mmol/L)) related to cardiovascular disease development in patients with Type 2 diabetes (n=80) through pharmacologic therapy and stepwise implementation of a behaviour modification program related to diet and physical activity. In comparison, the conventional treatment (n = 80) focused on achieving specific but less stringent biomedical targets (HbA1c <7.5%, blood pressure <160/95 mm Hg, total cholesterol < 250 mg/dl (6.48 mmol/L), triglycerides < 195 mg/dl (2.20 mmol/L)) through pharmacologic therapy only.

Participants in the intensive multifactorial intervention were followed by a multidisciplinary team consisting of a physician, nurse and registered dietician. The role of the physician was to oversee patient care and to monitor pharmacologic treatment while the nurse and dietician were responsible for the behaviour modification portion of the intervention and provided counseling related to diet and physical activity. Those in the conventional treatment group were followed by a physician only who was responsible for overseeing patient care and monitoring pharmacologic treatment. Participants were followed on average for 7.8 years. Researchers reported a decreased incidence of cardiovascular events in those who underwent intensive, multifactorial therapy through combined pharmacologic therapy and behaviour modification (diet, physical activity). An absolute 20% reduction in the risk of cardiovascular events was reported, a reduction that is far greater than in studies applying a single-factor treatment to hyperglycemia or hypertension only. Overall, the intensive, multifactorial clinical intervention resulted in a 50% reduction in cardiovascular disease and microvascular events in patients with Type 2 diabetes.
diabetes and microalbuminuria (Gaede et al., 2003). These results highlight not only the
importance of an intensive approach to diabetes therapy but also emphasize the
synergistic effects of a multifactorial treatment through combined pharmacologic means
and behaviour modification (diet and physical activity) in the prevention of both
macrovascular and microvascular complications in persons with Type 2 diabetes (Gaede
et al., 2003). Given these findings, it is important to evaluate the effectiveness of a
clinical intervention such as the one described in the Steno-2 study in a community
setting (Ménard et al., 2005).

In order to examine the translation of research to community practice, this study
will evaluate the efficacy of a community-based intensive multifactorial clinical
intervention in patients with Type 2 diabetes. Efficacy will be evaluated based on
improvement in biomedical outcomes such as body composition, glycemic control, blood
pressure and lipid profile over time in patients undergoing an intensive multifactorial
clinical intervention. Although improvement in these biomedical outcomes over time is
indicative of an effective intervention, current recommendations state that diabetes
therapy should adopt a target-driven approach that seeks to achieve near normal
biomedical values in patients with this condition (Gaede et al., 2003; Ménard et al.,
2005). These targets are based on a series of clinical practice guidelines that have been
developed by experts in this clinical field (Canadian Diabetes Association, 2003). In
order to appreciate the importance of achieving clinical targets such as those identified
for glycemic control in this study, an understanding of the development and rationale for using CPGs is necessary.

1.2.4.3 Clinical Practice Guidelines

Clinical practice guidelines (CPGs) are a group of statements that have been systematically developed to enhance practitioner and patient decisions related to appropriate health care in specific clinical circumstances (AACE, 2004). The ultimate goal of CPGs is to improve patient outcomes in a manner that will enhance their health and quality of life (Davis, 2000). Such is the case for the 2003 Clinical Practice Guidelines published by the Canadian Diabetes Association (Appendix A).

CPGs were originally developed in order to reduce inappropriate variations in clinical care, minimize harm, promote cost-effective practice and produce optimal health outcomes for patients (Brownman, Levine, Mohide, Hayward, Pritchard, Gafni et al., 1995). Overall, they were developed in order to improve the principles that guide clinical practice and to alleviate a portion of the economic burden related to poor utilization of health care services by professionals and patients alike (Brownman et al., 1995).

Physicians tend to act on incomplete information which may lead to subjectivity, bias, variability and creativity in the decision-making process (Hayward et al., 1997). The dissemination and implementation of CPGs were created in part to minimize these variations in clinical practice (Hayward et al., 1997). CPGs derived from evidence-based medicine can highlight the components of the clinical decision-making process that are objective thus leaving little room for variability in physician care (Hayward et al., 1997).
CPGs also enable the cohesive incorporation of traditional standards of care within scientific research paradigms (AACE, 2004). Thus, the guidelines developed can be viewed as consensus statements based on rigorous scientific study that is both valid and reliable (AACE, 2004). However, the experts who develop the guidelines are not the physicians who must implement the CPGs at the community level, thus producing a fraction between research and practice (Davis, 2000).

CPGs are primarily developed by specialists who are leaders in their field and have considerable research and/or clinical experience (Davis, 2000). The issue arises with respect to the dissemination of CPGs. CPGs are implemented primarily by front line general practitioners who may lack the same knowledge and expertise related to the given area of clinical practice (Davis, 2000). Thus, CPGs must be comprehensive for the condition covered but at the same time provide specific, relevant recommendations that can be cited in review articles and in performance or quality measurements (AACE, 2004). Outcomes must be specified for each recommendation and measures must be specified for assessment of each outcome in order for effective implementation (AACE, 2004). These recommendations not only ensure the quality of CPGs, but promote their implementation in clinical practice (Grol, 1997). However, there are a number of factors that will influence the implementation of these guidelines at the community level.

Previous research reports that the quality of CPGs, characteristics of the health care professional, characteristics of practice setting, incentives, regulation of CPGs and patient factors will each influence their implementation (Wolfe, Sharp & Wang, 1997).
In addition to these factors, current findings suggest that the expectations of these guidelines often surpass what is realistically achievable in a community practice (Wolfe et al., 1997). Therefore, this study will examine the feasibility of achieving the 2003 Canadian Diabetes Association clinical practice guidelines for glycemic control in a cohort of adults with Type 2 diabetes.

Although the feasibility of implementing CPGs in community practice has been questioned, experts in the area of diabetes care have attempted to develop methods to overcome these potential barriers. Researchers have concluded that some of the most effective approaches to CPG implementation include a multifaceted approach to clinical care that includes an educational component (Hayward et al., 1997). Such is the case for people living with Type 2 diabetes, where multifaceted clinical interventions have been successful in promoting the implementation of CPGs. In order to implement the Canadian Diabetes Association CPGs in a multifactorial fashion, the involvement of the entire diabetes health care team is integral (Canadian Diabetes Association, 2003). A description of the diabetes health care team involved in the community-based clinical intervention in this study follows.

1.2.4.4 Organization of Clinical Care

The organization of clinical care in a multifactorial intervention differs from the conventional approach where the physician (family doctor and/or specialist) and the patient were the sole stakeholders in decision-making related to diabetes care (Renders, Valk, Griffin, Wagner, Eijk van & Assendelft, 2001). The current approach to the
successful organization of clinical care in community-based intensive multifactorial intervention for diabetes requires the involvement and commitment of all members of the diabetes health care team (CDA, 2003; Greenhalgh, 1994). This was the case at the Diabetes Clinic evaluated in the present study. At the center of the diabetes healthcare team was the patient and his/her family (CDA, 2003; Greenhalgh, 1994; Renders et al., 2001). Other core members of the diabetes healthcare team included the endocrinologist at the Diabetes Clinic, the referring family physician/specialist and the diabetes educators (nurse educator and dietitian). Current literature indicates that additional individual and community healthcare professionals may also contribute to the team (CDA, 2003; Greenhalgh, 1994; Renders et al., 2001). At the Diabetes Clinic in the present study, an exercise therapist had recently been hired to provide group counseling sessions for exercise participation. In addition to the exercise therapist, the wider diabetes healthcare team was also composed of other medical specialists (e.g. ophthalmologists, cardiologists, neurologists, nephrologists, vascular surgeons, infectious disease specialists, gastroenterologists and obstetricians), other health professionals (e.g. nurses, dietitians, optometrists, pharmacists, podiatrists/chiropodists, social workers, psychologists and other mental health professionals) as well as community, public health and other health organizations (Funnell, 1996; Greenhalgh, 1994; Renders et al., 2001). According to current literature related to the organization of clinical care for diabetes, it is the responsibility of the diabetes healthcare team to provide comprehensive, shared care (Greenhalgh, 1994).
In order to achieve optimum patient care, communication and participation of all members of the diabetes health care team is essential (Funnell, 1996; Greenhalgh, 1994). This approach has been shown to empower the patient and increase his/her commitment and participation to their care while also serving to recognize and enhance the roles and practices of the physician and other team members (Greenhalgh, 1994). Current CPGs recommend free flow of information between health professionals and continuity of care (Canadian Diabetes Association, 2003). Given the time constraints that exist in every physician practice as well as at the Diabetes Clinic in the present study, some of the general education and counseling that is necessary to achieve clinical targets must be delegated to other members of the diabetes health care team such as the nurse educator or the dietitian (Greenlaugh, 1994). In the current study, patient education sessions were implemented in the form of diabetes education.

1.2.4.5 Diabetes Education

Diabetes education is a forum in which patients are given the tools necessary to achieve appropriate self-management (Norris, Lau, Smith, Schmid & Engelgau, 2002). Diabetes education empowers people to manage diabetes through education about nutrition, medication and insulin therapy, stress management, and preventive foot and eye care (Norris et al., 2002). The goals of diabetes self-management education are to optimize metabolic control, prevent acute and chronic complications of diabetes, and optimize quality of life, while limiting costs (Norris et al., 2002). Scientific research reports that there are significant knowledge and skill deficits in up to 50–80% of patients
with diabetes (Clement, 1995). Additionally, ideal glycemic control (HbA1c < 7.0%) is achieved in less than half of individuals with Type 2 diabetes in community practice (Harris, Eastman, Cowie, Flegal & Eberhardt, 1999). Diabetes self-management education has been shown to be effective in community settings, ultimately improving diabetes outcomes (Brown, 1992).

The inherent nature of diabetes education presents a challenge for patients, physicians and educators alike since it attempts to address behavioural change (Brown, 1992). It is therefore imperative to address behaviours that are consistent with the multifactorial approach to diabetes care (Brown, 1992). Given the relationship between poor dietary habits, sedentary behaviour and Type 2 diabetes, there exists evidence to support diet and exercise counseling by physicians and other health care professionals (Chakravarthy, Joyner & Booth, 2002).

### 1.2.4.7 Physician Counseling & Risk Factors for Cardiovascular Disease

Type 2 diabetes is a multifactorial disease that has been linked to a number of contributing factors, many of which are behavioural (Chakravarthy et al., 2002). Evidence suggests that there exists a genetic predisposition towards the disease, however most risk factors are behavioral and are thus potentially modifiable (Chakravarthy et al., 2002). Although change in lifestyle may seem to be the logical solution to prevent the onset of diabetes and prevent diabetes-related complications, patients often lack the tools and knowledge to do so (Egede & Zheng, 2002). In order to empower patients to initiate
the necessary lifestyle changes, physicians and other health professionals must capitalize on the opportunity to counsel patients (Egede & Zheng, 2002).

Although physician counseling is deemed one of the most effective means of encouraging patients to engage in positive lifestyle practices, physician counseling related to modifiable risk factors for diabetes and cardiovascular disease is reported to be less than optimal. In a study by Egede and Zheng (2002), physician counseling practices were evaluated in a group of American adults with and without Type 2 diabetes. Adults with Type 2 diabetes were more likely to receive counseling about increasing physical activity (67% vs. 36%, \( P<.001 \)), smoking cessation (78% vs. 67%, \( P = .01 \)), and eating foods with less fat (78% vs. 71%, \( P<.001 \)) compared with adults without Type 2 diabetes. Their findings suggest that although adults with Type 2 diabetes have a high prevalence of modifiable CVD risk factors, counseling by physicians about lifestyle modification is sub par (Egede & Zheng, 2002). In another national study of the general population, Mellen et al. (2004) reported that overall counseling rates were 35% for diet and 26% for exercise. Although counseling rates for diet and physical activity are superior among patients with Type 2 diabetes, the need to improve patient counseling for lifestyle modification by primary care physicians among all populations remains (Egede & Zheng, 2002). In order to improve counseling practices, one must understand the barriers that are associated to doing so.

Primary care physicians have mentioned several reasons for the low prevalence of counseling, including not having adequate time to provide counseling, having limited
training in counseling techniques, and being doubtful about the effectiveness of their counseling efforts (Chakravarthy et al., 2002). These reasons may partly explain the low prevalence of counseling of patients with Type 2 diabetes observed in the aforementioned studies. Although a higher incidence in behavioural counseling suggests improved biomedical outcomes (Harris, Caspersen, DeFriese & Estes, 1989), greater insight into the influence of other factors on the achievement of glycemic control is necessary (Keil & Kuulasmaa, 1989). Therefore, identification of factors that are predictive of glycemic control, including behavioural, biomedical and sociodemographic factors, is necessary in order to improve the approach to diabetes care and will thus be evaluated in this study.

1.2.5 Predictors of Glycemic Control

Studies such as the UKPDS and Steno-2 have clearly demonstrated that improved glycemic control decreases the risk of microvascular, and possibly macrovascular, complications in people with Type 2 diabetes. However, less is known about the factors that influence glycemic control (Benoit, Fleming, Philis-Tsimikas & Ji, 2005; Nichols et al., 2000). In order to create clinical interventions that will ultimately meet individual patient needs, health professionals must focus their approach to diabetes care on factors that are predictive of glycemic control (Benoit et al., 2005; Nichols et al., 2000).

Previous research has assessed the effect of a number of factors on the achievement of glycemic control including race, ethnicity (Harris et al., 1999), age (Shorr, Franse, Resnick, Di Bari, Johnson & Pahor, 2000; Nichols et al., 2000), BMI, emotional distress (Nichols et al., 2000), C-peptide level, disease duration, self-care,
dietary counseling (Blaum, Velez, Hiss & Halter, 1997), pharmacologic therapy, insurance status, smoking status and diabetes education (Benoit et al., 2005). Biomedical factors such as cholesterol levels, blood pressure have also been assessed (Benoit et al., 2005). In the current study, the following factors will be examined as potential predictors of glycemic control: disease duration, pharmacologic treatment, diabetes self-care, continuity of care, smoking status, age and gender.

**Disease Duration.** Study findings have differed on the association of glycemic control and disease duration. The U.K. Prospective Diabetes Study (UKPDS) suggested that glycemic control among individuals with diabetes decreases with disease duration and, thus, with age (UKPDS, 1998). These findings were supported by Nichols et al. (2000) who found that the longer someone had been diagnosed with diabetes, the harder it was to maintain glycemic control. Similar findings were reported by Benoit and colleagues (2005). Although diabetes self-care skills may improve with longer duration of disease, resistance to medication and the need for higher doses or additional medications increase over time. On the contrary, Blaum et al. (1997) reported that age was a predictive factor of improved glycemic control. In order to improve current understanding of the impact of disease duration on the achievement of glycemic control, this factor will be evaluated in this study.

**Pharmacologic Treatment.** In studies that have looked specifically at pharmacologic treatment as a predictor of glycemic control, researchers have reported that insulin therapy is a predictor of poor glycemic control (UKPDS, 1999). Benoit et al.
(2005) conducted a study that examined various factors including demographic, health status, treatment, access/quality of care, and behavioral factors and their association with poor glycemic control in a Type 2 diabetic, low-income, minority, San Diego (California) population. Benoit and colleagues (2005) reported that the mean A1c value (8.3%) of insulin users in the study was significantly higher than that of patients following treatment with oral hypoglycemic agents only, regardless of the number of agents prescribed. These findings were equivalent to the mean value of insulin users in the NHANES III data (Harris, Flegel, Cowie, Eberhardt, Goldstein, Little et al., 1998). Given the impact of pharmacologic therapy on glycemic control, this study will examine the impact of pharmacologic therapy on the achievement of clinical targets for hemoglobin A1c as defined by the 2003 CDA CPGs.

**Self-Monitored Blood Glucose (SMBG).** A number of clinical trials assessing the impact of glycemic control on diabetes complications have included SMBG as part of multifactorial interventions and have suggested that SMBG is a component of effective diabetes therapy (Harris, 2001; Kennedy, 2001). A glucose meter is a clinical tool that combines technological sophistication with speed and ease of use that has greatly enhanced the potential for all diabetic patients to monitor their blood glucose between clinic appointments (Kennedy, 2001). SMBG allows the patient to detect subtle hypoglycemia, asymptomatic hyperglycemia as well as fluctuations in glycemia instantaneously (Harris, 2001). In theory, access to this information should empower
patients to make appropriate changes in lifestyle and/or pharmacologic treatment, which should lead to lower HbA1c levels (Harris, 2001).

For people with Type 2 diabetes who are treated with lifestyle modifications alone or in combination with oral hypoglycemic agents, the optimal frequency of SMBG remains unclear (American Diabetes Association, 2000; Klein, Oboler, Prochazka, Oboler, Frank, Glugla et al., 1993). However, recent evidence indicates benefits of testing on glycemic control, especially when this information is used to make appropriate, timely treatment adjustments (Centers for Disease Control, 1999). In people with Type 2 diabetes treated with oral hypoglycemic agents, testing at least once daily is associated with a 0.6% lower hemoglobin A1c than less frequent monitoring (Centers for Disease Control, 1999). In those managed by lifestyle alone, any frequency of testing is associated with a lower hemoglobin A1c (Centers for Disease Control, 1999).

Individuals who are undergoing intensive management with the goal of near normalization of blood glucose levels can use information obtained from pre-prandial and bedtime testing, as well as intermittent postprandial and night-time tests, to adjust insulin dosages (Harris, 2001). Therefore, this study will determine whether the frequency of SMBG is a significant predictor of glycemic control following an intensive multifactorial intervention.

**Continuity of Care.** Continuity of care encompasses a number of aspects related to patient care including accessibility to medical services, physician contact and contact with other health care providers (Nair, Dolovich, Ciliska & Lee, 2005). Given the
increasing prevalence and chronic nature of diabetes and its complications, it is logical to assume that a relationship may exist between continuity of care and outcomes of diabetes care such as glycemic control (Nair et al., 2005).

Little research examining the impact of physician contact has been conducted among adults with Type 2 diabetes (Kaufman, Halvorson & Carpenter, 1999). However, the impact of physician visits on blood glucose control has been examined in adolescents with Type 1 diabetes. Kaufman et al. (1999) examined the relationship between diabetes outcome as measured by hemoglobin A1c and the number of multidisciplinary clinic visits per year in children and youth with diabetes. Researchers retrospectively compared glucose control, as defined by hemoglobin A1c, between patients with one to two visits versus three to four visits over the three years. These researchers reported a significant difference in the mean hemoglobin A1c levels between subjects with one to two visits versus three to four visits over the three years of this study. Although the mean age of patients with one to two visits was 13.6 ± 4.5 years and was 10.8 ± 4.6 years with three to four visits, the difference between hemoglobin A1C levels for subjects with one to two visits versus three to four visits (8.9 ± 1.7% versus 8.1 ±1.3%, respectively) persisted when analyzed grouped by <13 years versus >13 years. These findings suggest that increased physician contact, regardless of the age of the juvenile patient, improved diabetic outcomes as evaluated by hemoglobin A1c (Kaufman et al., 1999). Although these findings are not directly transferable to an adult population, one may question whether a similar relationship exists (Kaufman et al., 1999). Therefore, the current study
will examine the association between the frequency of physician visits and the achievement of glycemic control in this group of patients with Type 2 diabetes.

**Smoking and Diabetes.** Cigarette smoking is another factor that has been consistently linked to the incidence of a number of chronic diseases and has long been known to worsen the prognosis of patients with diabetes (Solberg, Desai, O’Connor, Bishop & Devlin, 2004). Smoking is a major risk factor for both macrovascular and microvascular complications (Solberg et al., 2004). This evidence has been supported by additional research that has concluded that smoking increases insulin resistance, worsens diabetes control, and may even induce the disease (Mulhauser, 1994; Haire-Joshu, Glasgow & Tibbs, 1999). In addition to the other factors previously reviewed, this study will determine the association between smoking status (nonsmoker, previous smoker, current smoker) and glycemic control following an intensive multifactorial clinical intervention.

### 1.3 Statement of the Purpose and Hypotheses

#### 1.3.1 Purpose

It has been confirmed that intensive target-driven interventions such as those in the Steno-2 study and UKPDS will decrease the incidence of microvascular and macrovascular complications in people with Type 2 diabetes (UKPDS Group 1998; Gaede et al., 2003). In the Steno-2, improvement in glycemic control as well as hypertension and diabetic dyslipidemia, was achieved through multifactorial pharmacologic and lifestyle interventions. However, little research has been invested into examining the effectiveness of an intensive multifactorial clinical intervention in a
Therefore, the primary objective of this study will be to examine the effectiveness of an intensive multifactorial clinical intervention at a community clinic on selected biomedical outcomes.

In addition to evaluating the effectiveness of this clinical intervention, this study will also examine the feasibility of implementing and achieving clinical targets for glycemic control in this population. Therefore, this study will also examine the feasibility of achieving clinical targets for hemoglobin A1c as defined by the 2003 Canadian Diabetes Association clinical practice guidelines, in a cohort of patients enrolled in an intensive multifactorial community-based intervention for people with Type 2 diabetes.

In order to gain further insight into the factors that mitigate the achievement of clinical targets for hemoglobin A1c, this study will examine the association between a number of factors including age, gender, pharmacologic treatment, disease duration, smoking status, diabetes self-care and continuity of care, with glycemic control. The identification of factors that predict the achievement of glycemic control as defined by clinical practice guidelines may assist healthcare professionals in developing interventions that are further individualized to each patient. Therefore, a secondary objective of this study will be to identify factors that are predictive of glycemic control following the first twelve months of an intensive multifactorial clinical intervention for Type 2 diabetes.
1.3.2 Hypotheses

The hypotheses related to the purpose of this study are as follows:

1. Participants included in this study will experience a clinically significant improvement in hemoglobin A1c, blood pressure, HDL cholesterol, LDL cholesterol, triglycerides, total cholesterol and total cholesterol: HDL ratio over 12 months. Participants will not experience a significant improvement (decrease) in body mass index.

Studies such as the Steno-2 study have consistently shown the efficacy of an intensive multifactorial clinical intervention in patients with Type 2 diabetes (Gaede et al., 2003). Patients in the Steno-2 study demonstrated significant improvement in glycemic control, blood pressure and lipid profile (Gaede et al., 2003). In order to achieve glycemic control in people with uncontrolled complicated diabetes, such as the participants in this cohort, intensive insulin therapy is usually employed. Past research has consistently reported an increase in overall body weight and fat mass in patients undergoing intensive insulin therapy (Gaede et al., 2003; Ménard et al., 2005). Therefore, patients in this study are expected to improve on all parameters but body composition.

2. Participants enrolled in the intensive multifactorial clinical intervention will achieve clinical practice guidelines for hemoglobin A1c at the end of the twelve month intervention.

Randomized control studies have demonstrated that the achievement of clinical practice guidelines in people with Type 2 diabetes has been successful, particularly
related to glycemic control (Ménard et al., 2005; UKPDS Group, 1999). Based on the findings of previous research, it is estimated that participants will achieve clinical targets for glycemic control at the end of the twelve month intervention.

3. Age, pharmacologic therapy, smoking status, frequency of visits, self-monitored blood glucose testing, disease duration at baseline will be significant predictors of glucose control (hemoglobin A1c <7.0%) over twelve months. Gender will not have a significant effect.

Previous research has noted the association of each of these factors with the achievement of glycemic control (Benoit et al., 2005; Baum et al., 1997; Nichols et al., 2000). Given the role of each factor in the pathophysiology and management of disease, it is expected that each will be a significant predictor of glycemic control at the end of the twelve month intervention.

1.3.3 Limitations

There are number of limitations associated with this study. Given the retrospective nature of the study there are a number of controls that researchers were unable to apply to the study design. The data obtained from the chart review is a reflection of the physician’s recording practices and may thus be inherently limited. This limitation is of relevance to any of the factors examined in this study. In terms of the intervention period specified in this study, researchers were unable to precisely define the twelve month period in which the patient was followed. Thus the appointment closest to the 1-year follow-up date was employed. Additional limitations include the inability to assess the
impact of dietary counseling and dietary habits. Researchers were also unable to examine the impact of physician physical activity counseling practices on actual physical activity participation. Although the two groups were defined in function of achievement of glycemic control, differentiation between groups (Hb A1c >7.0%, Hb A1c <7.0%) may not be sufficiently sensitive to detect true differences.

1.3.4 Delimitations

Delimitations associated with this project are few. The findings of this study can only be applied to individuals with Type 2 diabetes undergoing an intensive multifactorial clinical intervention in a community-based setting similar to that of the Saskatoon Diabetes Clinic. Additionally, the findings may only be applied to individuals between the age of 36 and 78 years.
CHAPTER 2
METHODS

2.1 Introduction

The current study involved a retrospective analysis of data contained in patient charts from the Diabetes Clinic located at Saint Paul’s Hospital in Saskatoon, Saskatchewan. Therefore, the methods section of this project will include a description of the clinical protocols in place at the Diabetes Clinic, in addition to the procedures undertaken to examine the purpose and hypotheses of the current study.

2.2 Overview of the Diabetes Clinic

2.2.1 Mandate of the Diabetes Clinic

In April 2000, Saskatoon’s Diabetes Clinic opened in response to the promising results of intensive pharmacologic clinical interventions such as the landmark U.K. Prospective Diabetes Study (UKPDS). The mandate of the clinic is to manage the patient’s cardiovascular disease risk profile through an intensive, multifactorial clinical intervention in order to prevent and/or manage microvascular and macrovascular diabetes-related complications. Diabetes care is managed through pharmacologic therapy overseen by a physician and behaviour modification counseling (diet, physical activity) directed by certified consultants who are members of a multidisciplinary team (physician, nurse educator, registered dietician). Management is based on clinical practice guidelines derived from the UKPDS as well as the 2003 Canadian Diabetes clinical practice guidelines. Located at Saint Paul’s Hospital, a large number of patients with diabetes and
other metabolic disorders (n = 1600) have been treated by the medical staff at the Diabetes Clinic since its opening in April, 2000. At the time which this study was conducted, 488 patients with Type 2 diabetes were actively receiving treatment from members of the healthcare team of the Diabetes Clinic.

2.2.2 Protocol of the Diabetes Clinic

2.2.2.1 Initial Assessment

Patients attending the multifactorial clinical intervention at the Diabetes Clinic were seen based on a clinical referral made by their family physician or another specialist. Patients having received a diagnosis of complicated uncontrolled diabetes by their family physician or another specialist were referred to the clinic in order to receive more specialized diabetes care. At the initial assessment, patients underwent a full physical examination and provided the physician with information related to their health status (Appendix B). The physical examination consisted of assessments of the following parameters:

- Height
- Body weight
- Body composition: body mass index (BMI), waist circumference
- Vital signs: heart rate, blood pressure
- Cardiovascular exam
- Respiratory exam
- Abdominal examination
• Sensory neurological exam of the extremities
• Distal exam of the lower member

Information related to pharmacologic treatment (oral hypoglycemic agents, insulin), pre-existing health or diabetic complications, smoking status as well as demographic information such as age, geographical residence and employment status were also recorded by the physician at the initial assessment. Information related to dietary habits and physical activity participation was also obtained by the physician at that time. Any pertinent health-related investigations such as hemoglobin A1c, lipid profile and urinalysis were ordered by the physician. In order to evaluate the patient’s readiness for change related to behavioural factors, a global assessment of the patient’s progression through Prochaska’s Model of Stages of Change (Prochaska & DiClemente, 1982) was performed by the physician. Patients who were in the preparation or contemplation stages Prochaska’s Model of Stages of Change (Prochaska & DiClemente, 1982) were referred to a dietitian and/or diabetes educator.

2.2.2.2. Follow-up Appointments

Follow-up appointments were scheduled every four months following the initial assessment or as deemed necessary by the physician. At subsequent visits, a complete physical examination was performed by the physician who assessed the same parameters as those previously mentioned (Appendix C). Diabetes-related pharmacologic treatment was re-assessed based on previously ordered laboratory investigations (hemoglobin A1c, urinalysis, lipid profile) and patient feedback related to intolerance or side effects of
current drug treatment. Any change in smoking status or demographic information such as geographical residence and employment status were recorded by the physician. Additionally, dietary habits and physical activity participation was re-assessed by the physician and changes were noted in the patient chart. Any pertinent laboratory investigations such as hemoglobin A1c, lipid profile and urinalysis were ordered by the physician. Referral to a dietitian and/or diabetes educator was made based on the patient’s progression through the Transtheoretical Model (Prochaska & DiClemente, 1982) using the same rationale as that previously described for the initial assessment.

2.2.2.3. Counseling

Counseling at the Diabetes Clinic took place in three given areas: diet, physical activity and diabetes education. As stated in the previous sections, referral to these sessions was based on the patient’s progression through the Transtheoretical Model (Prochaska & DiClemente, 1982). All counseling was based on the 2003 CDA CPGs. Dietary counseling was conducted by a registered dietitian on an individual basis. Dietary counseling included recommendations to follow Canada’s Guidelines for Healthy Eating while choosing low-glycemic-index foods in place of high-glycemic-index foods within the same category in order to help optimize glycemic control. Additionally, patients were counseled to restrict combined saturated fats and trans fatty acids to <10% of energy and include meal plans that favour monounsaturated fats. Patients were counseled to include foods rich in polyunsaturated omega-3 fatty acids and plant oils when possible. For patients undergoing intensive insulin treatment regimens,
education on matching insulin to carbohydrate content (e.g. carbohydrate counting) was performed. Lastly, patients were counseled to limit alcohol intake in order to avoid the risk of morning hypoglycemia resulting from alcohol consumed two to three hours after the previous evening’s meal.

With respect to physical activity, counseling was also based on the recommendations of the 2003 CDA CPGs. Physical activity counseling sessions were conducted by a certified exercise therapist in a group setting. Patients were encouraged to engage in moderate-intensity aerobic exercise totaling 150 minutes each week, spread over at least three nonconsecutive days of the week. For patients who were willing to do so, recommendations to accumulate more than four hours of moderate-intensity aerobic exercise per week were made by the exercise therapist. In terms of resistance exercise, patients were counseled to perform resistance exercise three times per week.

The last form of counseling conducted at the Diabetes Clinic was in the form of diabetes education. These sessions were conducted by a nurse educator on an individual basis. At these sessions, patients received information related to blood glucose self-management, diabetes foot care and their individualized pharmacologic treatment. In these sessions, patients prescribed insulin were taught how to administer injections and adjust insulin doses with respect to home blood glucose readings. Counseling related to psychosocial issues stemming from the diagnosis was also conducted in these sessions.
2.3 Thesis Procedures

2.3.1 Study Consent and Approval

Prior to participant selection, all patient files and contents were first coded and then entered into a database by an independent group of researchers in order to preserve the anonymity and confidentiality of the participants. Given that the information for this thesis was from a database where aggregated data could not be associated with any one individual or group of individuals, ethical approval from the University of Saskatchewan Behavioural Ethics Committee was waived according to Section 1.1.5a of the Guidelines for Ethics Review of Research Involving Human Subjects.

2.3.2 Participant Recruitment

Since its opening in April 2000, there are approximately 1600 patients who have received treatment at the Diabetes Clinic for a variety of metabolic conditions including Type 1 diabetes, Type 2 diabetes, Cushing’s disease and disorders of the thyroid gland. The patients attending the Diabetes Clinic were referred to this center in order to receive specialized care for complicated, uncontrolled metabolic disorders. At the time which the study was conducted, there were approximately 1200 patients who were actively receiving treatment at the clinic for these various health disorders. Given the role of a multidisciplinary intervention in the management of Type 2, this particular cohort of patients was selected in order to examine the impact of a multifaceted clinical intervention on biomedical outcomes as well as the incidence of physical activity.
counseling among these patients. Therefore, only patients with Type 2 diabetes participating in a multifactorial clinical intervention at the Diabetes Clinic were included for the purpose of this project (n = 488).

2.3.3 Cohort Selection and Eligibility

There were 488 patients with Type 2 diabetes at the clinic who were actively receiving treatment at the time of the study. In order to be eligible for this study, participants were required to be currently undergoing an intensive, multifactorial clinical intervention for patients with Type 2 diabetes at the Saint Paul’s Hospital Diabetes Clinic in Saskatoon. Patients were eligible only if they had begun treatment at the clinic following the dissemination of the 2003 Canadian Diabetes Association Clinical Practice Guidelines (Appendix A). The sample was thus reduced to 161 participants. Additionally, participants were included if they had attended an initial patient assessment at the Diabetes Clinic, in addition to a follow-up visit at twelve months. Individuals who had been followed by the medical staff at the Diabetes Clinic for a period less than twelve months were not included in this study. Once these inclusion and exclusion criteria were considered, the number of participants who were referred to the clinic following the dissemination of the 2003 CDA Clinical Guidelines and who had been followed for a minimum period of 12 months (n = 161) decreased to 70 (33 males, 37 females) between the ages of 36 and 78 years.
2.3.4 Sample Size and Justification

The sample size used in this research design was based upon careful consideration of both statistical power and feasibility. It was important to have a large enough sample to increase the statistical power of all analyses and therefore allow the proposed research questions to be answered effectively. However, the retrospective nature of the study had to be recognized and evidently did place limitations on the sample size that was chosen. For this study, the alpha level for all statistical tests was set at $p<0.05$. According to Cohen (1969), in the behavioural sciences, beta ($\beta$) should be set at four times the level of alpha, in order to reduce the chance of making a type I error (rejecting a true null hypothesis). Since power is $1 - \beta(1 - 0.2)$, this sets the power at 0.8, which is accepted as an appropriate level in behavioural research (Thomas and Nelson, 2001). Selecting a sample size that would help assess the practical significance of any relationships among independent and dependent variables was also considered. In the UKPDS, a 1% decrease in glycated hemoglobin resulted in a significant decrease in the incidence of microvascular complications. Therefore, the effect size selected for this study was 1. An effect size (ES) of 1, combined with a power level of 0.80, estimated that approximately 35 participants would be required (Thomas and Nelson, 2001). Using the same effect size, a sample size of approximately 45 participants would increase power to 0.90 (Thomas and Nelson, 2001).
2.3.5 Measures

2.3.5.1 Physical Measurements

2.3.5.1.1 Body Composition

Weight

Weight was measured by a clinical assistant at the initial assessment and at each subsequent visit using a Health-o-meter Pro Series weigh scale (Health-o-meter Inc., Bridgeview, Illinois). Patients were asked to remove their shoes and outdoor apparel before measuring their weight. The clinical assistant instructed patients to step onto the scale, standing at maximum height, head erect. Patients were instructed to remain stationary and on the scale until an accurate measurement were taken. Body weight measurements were recorded in kilograms to one decimal.

Height

Height was measured by a clinical assistant at the initial assessment and each follow-up visit using the Health-o-meter Pro Series stadiometer (Health-o-meter Inc., Bridgeview, Illinois). Patients were instructed to remove their shoes and stand against the wall. The top of the stadiometer was positioned flush with the top of the patient’s head. Patients were instructed to stand at their maximum height, after which their height was recorded. Height measurements were recorded in centimeters to one decimal place.

Body Mass Index

Body Mass Index (BMI) was calculated using the following formula:

\[ \text{BMI} = \frac{\text{weight (kg)}}{\text{height}^2 (\text{m})} \]
The values for weight and height were obtained using the methods described above.

**Waist Circumference**

Waist circumference was measured by a clinical assistant at the initial assessment and at each subsequent visit using a 200 cm cloth measuring tape. Measurement of waist circumference was taken fully-clothed, at the narrowest point of the patient’s torso.

**2.3.5.1.2 Blood Pressure**

Blood pressure was assessed by the physician using a Tycos 767 wall model aneroid sphygmomanometer (Welch Allyn Inc., Skaneateles Falls, NY). Systolic and diastolic blood pressures were assessed at the initial assessment and at each subsequent visit. Patients were asked to lie on the examining table and relax for a brief period after which blood pressure was measured in the supine position. Blood pressure was measured once in millimeters of mercury and recorded to the nearest millimeter.

**2.3.5.1.3 Laboratory Investigations**

All laboratory investigations were conducted by a subsidiary of the Saskatchewan Provincial Lab under the direction of Saskatchewan Health using the set protocol and procedures established by Saskatchewan Health.

**Hemoglobin A1c**

Assessment of hemoglobin A1c was performed following the initial assessment and following each subsequent visit to the clinic. Hemoglobin A1c allows a long-term assessment of the patient’s blood sugar control. As opposed to a fasting glucose test which simply gives a snapshot of glucose control at a given time, hemoglobin A1c levels
represent the management of blood sugar levels over the past thirty days. Thus, assessment of hemoglobin A1c provides a more accurate representation of glycemic control, particularly when assessments are more than 60 days apart.

Analysis of hemoglobin A1c was performed using the Variant II Hemoglobin A1c Program. This method uses the principles of ion exchange high performance liquid chromatography in order to accurately separate glycosylated hemoglobin sample without interference from Schiff base, lipemia or temperature fluctuations.

**Lipid Profile**

The lipid profile was assessed following the initial assessment and on a yearly basis thereafter. The lipid profile is an objective method of risk assessment for the development of cardiovascular disease in the general population as well as in individuals with Type 2 diabetes. Coronary atherosclerosis correlates with high total cholesterol levels, high triglycerides, high LDL-cholesterol and low HDL-cholesterol concentrations (Cosford, 1999). In order to perform the analysis of the lipid profile, a fasting blood specimen was required. After a 10-hour fast, patients were required to report to a medical laboratory in the community in order for a blood sample to be drawn (NCCLS, 1991). Approximately 5 to 7 mL of blood was drawn into a non-heparinized SST tube by a medical laboratory technician (NCCLS, 1991). The same blood sample was used to assess all parameters of the lipid profile (NCCLS, 1991).
Total Cholesterol

Total cholesterol was assessed using the VITROS 950 CHOL slide method and the VITROS 950 Chemistry Products Calibrator Kit 2 on VITROS Chemistry Systems. The VITROS 950 CHOL Slide is a multilayered analytical element coated on a polyester support that employs an enzymatic method similar to that described by Calam (1988).

High Density Lipoprotein Cholesterol

HDL cholesterol was assessed using the VITROS 950 magnetic HDL Cholesterol Reagent with VITROS 950 CHOL slide method and the VITROS 950 Chemistry Products Calibrator Kit 2 on VITROS Chemistry Systems. HDL particles are separated by the precipitation of LDL and VLDL particles using dextran sulphate and magnesium chloride (NCEP, 1990). Non-HDL particles are also separated from the sample by polymer-coated iron particles in the reagent (NCEP, 1990). The precipitated lipoproteins are extracted from the sample once a magnetic field is applied (NCEP, 1990).

Triglycerides

Analysis of plasma triglycerides was performed using the VITROS 950 TRIG Slide Method with VITROS 950 TRIG slides and the VITROS 950 Chemistry Products Calibrator Kit 2 on VITROS Chemistry Systems. The VITROS 950 TRIG Slide is a multilayered analytical element coated on a polyester support that employs an enzymatic method similar to that described by Spayd (1978).
2.4 Statistical Analysis

The SPSS (version 14.0) statistical package was used to analyze the data.

**Hypothesis 1.** In order to assess the effectiveness of the intensive multifactorial clinical intervention, change in glycemic control (hemoglobin A1c) over time was assessed using a paired sample t-test. Change in systolic and diastolic blood pressure as well as change in BMI, waist circumference, HDL-cholesterol, LDL-cholesterol, triglycerides, total cholesterol, total cholesterol: HDL ratio and microalbumin over time was also assessed using a paired t-test.

**Hypothesis 2.** Descriptive statistics were used to identify patients who had attained glycemic control at twelve months as defined by hemoglobin A1c <7.0%.

**Hypothesis 3.** The combined influence of age, disease duration, pharmacologic treatment, continuity of care, smoking status, diabetes self care and gender was investigated using logistic regression. Achievement of glycemic targets at twelve months was interpreted as a categorical variable (achieved or not achieved). Coding was performed such that individuals who achieved clinical practice guidelines for glycemia at 12 months (HbA1c <7.0%) received a score of “1” and those who did not received a score of “0” (HbA1c >7.0%). Each variable was entered in to the model individually to determine if it was a significant predictor. All significant predictors were presented in the final model.

The goodness of fit of the model was assessed using the model chi square, likelihood ratio and Hosmer-Lemeshow goodness of fit tests. Statistical significance of
the B coefficients in the model was assessed using the Wald statistic. Effect size was evaluated using Nagelkerke's R-Square.

The alpha level of significance for all statistical tests was set at p< 0.05.

2.5 Data Screening

2.5.1 Missing Data

Prior to running any statistical analysis, the data was screened for missing data for outcome variables. Overall, all participants had complete data for the glycemic control variable (hemoglobin A1c). Data for BMI, systolic and diastolic blood pressure were complete at both time points. Baseline and twelve month values were available for the following variables: waist circumference (n = 5), HDL (n = 29), LDL (n = 28), triglycerides (n = 29), total cholesterol (n = 29), total cholesterol:HDL ratio (n = 24) and microalbumin (n = 10). If a participant was missing values for any time point on any variable, he or she was excluded from that particular analysis. Since waist circumference and microalbumin contained incomplete data sets (<10 entries), these variables were excluded from the analysis. The data was then scanned for missing data related to the following variables: age, gender, pharmacologic treatment, frequency of physician visits, disease duration, smoking status and frequency of self-monitored blood glucose testing. All participants (n = 70) had complete data sets for these variables.

2.5.2 Evaluation of Normality

Given that binary logistic regression does not require the assumptions of normality, linearity, nor homogeneity of variance to be fulfilled, these parameters were
Outliers were defined as values that deviated from the mean by more than three standard deviations. All variables were screened for outliers. Once outliers were discovered for any of the variables, the participant was excluded from the sample on that particular variable. The logistic regression was repeated on the sample once outliers were excluded from analysis. Given that the results of the data analysis were similar after including and excluding any outliers, the decision was made to include the outliers in the final analysis.
CHAPTER 3
RESULTS & DISCUSSION

3.1 Results

3.1.1 Baseline Analysis of Participant Characteristics

A summary of general participant characteristics is reported in Table 3.1. Overall, 98.6% of the sample at baseline was following pharmacologic therapy of which 11.4% was following insulin therapy only, 57.1% minimum one oral hypoglycemic agent only and 30% combined insulin and oral hypoglycemic therapy. In terms of smoking status, 15.7% were current smokers, 17.1% had never smoked and 67.1% were former smokers. A large number of patients (24.3%, n = 17) reported to the clinic with pre-existing health conditions that impact physical function. These pre-existing health conditions included chronic obstructive pulmonary disease (COPD) (2.9%, n = 2), asthma (2.9%, n = 2), arthritis (osteo or rheumatoid) (11.4%, n = 8), lower limb amputation (4.3%, n = 3) and severe peripheral vascular disease (2.9%, n = 2). Additionally, 27.1% began the clinical intervention with pre-existing diabetic complications (proliferative retinopathy, peripheral neuropathy, and nephropathy). Overall disease duration was 7.4 ± 7.5 years. 44.3% performed SMBG testing once per day, 7.1% once per week, 35.7% once per month and 12.9% not at all. On average, patients in this cohort attended 2.3 ± 0.7 physician visits per year.

A summary of baseline biomedical characteristics is reported in Table 3.2. The average age of participants included in the study was 58.3 ± 11.1 years (females, 58.2 ±
10.8 years; males, 58.3 ± 11.7 years). Overall, this population of patients with Type 2 diabetes entered the clinical intervention with poor glucose control (Hb A1c 8.76 ± 1.88%) and was overall classified as obese (31 ± 5 kg/m²). Blood pressure control (systolic blood pressure 132 ± 18 mm Hg), as well as LDL cholesterol (2.67 ± 0.53 mmol/L), triglycerides (2.17 ± 1.19 mmol/L) and total cholesterol/HDL ratio (5.02 ± 1.44) were above the clinical targets defined by the 2003 CDA CPGs. Diastolic blood pressure (76 ± 9 mm Hg) was below the clinical target for this outcome. Although the 2003 CDA CPGs do not set clinical targets for HDL cholesterol and total cholesterol, the overall baseline HDL cholesterol values, 1.11 ± 0.28 mmol/L met the recommendations for management of dyslipidemia in the Canadian general population while the baseline total cholesterol values (4.92 ± 0.98 mmol/L) did not (Genest, Frohlich, Fodor & McPherson, 2003).
<table>
<thead>
<tr>
<th></th>
<th>Overall (n = 70)</th>
<th>Male (n = 33)</th>
<th>Female (n = 37)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>58.3 ± 11.1</td>
<td>58.31 ± 11.67</td>
<td>58.24 ± 10.81</td>
</tr>
<tr>
<td><strong>Disease Duration (years)</strong></td>
<td>7.4 ± 7.5</td>
<td>8.18 ± 7.68</td>
<td>6.65 ± 7.33</td>
</tr>
<tr>
<td><strong>Pharmacologic Therapy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>1.4%</td>
<td>3.0%</td>
<td>------</td>
</tr>
<tr>
<td>Oral Hypoglycemic Agent(s) only</td>
<td>57.1%</td>
<td>45.5%</td>
<td>67.6%</td>
</tr>
<tr>
<td>Insulin only</td>
<td>11.4%</td>
<td>15.2%</td>
<td>8.1%</td>
</tr>
<tr>
<td>Oral Hypoglycemic Agent(s) + Insulin</td>
<td>30%</td>
<td>36.4%</td>
<td>24.3%</td>
</tr>
<tr>
<td><strong>Continuity of Care</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 physician visits/year</td>
<td>84.3%</td>
<td>87.9%</td>
<td>81.1%</td>
</tr>
<tr>
<td>3 physician visits/year</td>
<td>7.1%</td>
<td>3.0%</td>
<td>10.8%</td>
</tr>
<tr>
<td>4 physician visits/year</td>
<td>7.1%</td>
<td>6.1%</td>
<td>8.1%</td>
</tr>
<tr>
<td>5 physician visits/year</td>
<td>1.4%</td>
<td>3.0%</td>
<td>------</td>
</tr>
<tr>
<td><strong>Smoking Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonsmoker</td>
<td>17.1%</td>
<td>21.2%</td>
<td>13.5%</td>
</tr>
<tr>
<td>Current Smoker</td>
<td>15.7%</td>
<td>15.2%</td>
<td>16.2%</td>
</tr>
<tr>
<td>Former Smoker</td>
<td>67.1%</td>
<td>63.6%</td>
<td>70.3%</td>
</tr>
<tr>
<td><strong>Self-Monitored Blood Glucose</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>12.9%</td>
<td>18.2%</td>
<td>8.1%</td>
</tr>
<tr>
<td>Testing daily</td>
<td>44.3%</td>
<td>36.4%</td>
<td>51.4%</td>
</tr>
<tr>
<td>Testing weekly</td>
<td>7.1%</td>
<td>6.1%</td>
<td>8.1%</td>
</tr>
<tr>
<td>Testing monthly</td>
<td>35.7%</td>
<td>39.4%</td>
<td>32.4%</td>
</tr>
<tr>
<td><strong>Pre-existing Health Conditions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>24.3%</td>
<td>24.2%</td>
<td>24.3%</td>
</tr>
<tr>
<td>1. Chronic Obstructive Pulmonary Disease (COPD)</td>
<td>2.9%</td>
<td>3.0%</td>
<td>2.7%</td>
</tr>
<tr>
<td>2. Asthma</td>
<td>2.9%</td>
<td>------</td>
<td>5.4%</td>
</tr>
<tr>
<td>3. Arthritis</td>
<td>11.4%</td>
<td>9.1%</td>
<td>13.5%</td>
</tr>
<tr>
<td>4. Lower limb amputation</td>
<td>4.3%</td>
<td>9.1%</td>
<td>------</td>
</tr>
<tr>
<td>5. Severe peripheral vascular disease</td>
<td>2.9%</td>
<td>3.0%</td>
<td>2.7%</td>
</tr>
<tr>
<td>No</td>
<td>75.7%</td>
<td>75.8%</td>
<td>75.7%</td>
</tr>
</tbody>
</table>
### Table 3.2 Baseline Biomedical Characteristics of Participants in an Intensive Multifactorial Diabetes Intervention (mean ± SD)

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Overall</th>
<th>CDA † CPG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (m)</td>
<td>1.74 ± 0.06</td>
<td>1.62 ± 0.06</td>
<td>1.68 ± 0.08</td>
<td>----</td>
</tr>
<tr>
<td>n = 70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>95.4 ± 7.5</td>
<td>92.1 ± 0.1</td>
<td>93.6 ± 18.9</td>
<td>----</td>
</tr>
<tr>
<td>n = 70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>31 ± 5</td>
<td>35 ± 7</td>
<td>33 ± 6</td>
<td>----</td>
</tr>
<tr>
<td>n = 70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemoglobin A1c (%)</td>
<td>8.76 ± 1.88</td>
<td>8.42 ± 1.40</td>
<td>8.58 ± 1.64</td>
<td>≤7.0</td>
</tr>
<tr>
<td>n = 70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic Blood Pressure</td>
<td>132 ± 18</td>
<td>131 ± 18</td>
<td>131 ± 18</td>
<td>≤130</td>
</tr>
<tr>
<td>(mm Hg) n = 70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diastolic Blood Pressure</td>
<td>76 ± 11</td>
<td>76 ± 9</td>
<td>76 ± 10</td>
<td>≤80</td>
</tr>
<tr>
<td>(mm Hg) n = 70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDL-cholesterol (mmol/L)</td>
<td>0.99 ± 0.22</td>
<td>1.21 ± 0.28</td>
<td>1.11 ± 0.28</td>
<td>≥1.04‡</td>
</tr>
<tr>
<td>n = 52</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDL-cholesterol (mmol/L)</td>
<td>2.67 ± 0.53</td>
<td>3.17 ± 0.86</td>
<td>2.94 ± 0.77</td>
<td>≤2.5</td>
</tr>
<tr>
<td>n = 49</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triglycerides (mmol/L)</td>
<td>2.17 ± 1.19</td>
<td>2.07 ± 1.02</td>
<td>2.12 ± 1.09</td>
<td>≤1.5</td>
</tr>
<tr>
<td>n = 52</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Cholesterol (mmol/L)</td>
<td>4.59 ± 0.75</td>
<td>5.20 ± 1.07</td>
<td>4.92 ± 0.98</td>
<td>≤4.14‡</td>
</tr>
<tr>
<td>n = 53</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Cholesterol:HDL Ratio n = 49</td>
<td>5.02 ± 1.44</td>
<td>4.45 ± 0.98</td>
<td>4.70 ± 1.21</td>
<td>≤4.0</td>
</tr>
</tbody>
</table>

† CDA, 2003
‡ Genest et al., 2003
3.1.2 Effectiveness of A Community-Based Intensive Multifactorial Clinical Intervention

**Hypothesis 1:** Participants included in this study will experience a clinically significant improvement in hemoglobin A1c, blood pressure, HDL cholesterol, LDL cholesterol, triglycerides, total cholesterol and total cholesterol: HDL ratio over 12 months. Participants will not experience a significant improvement (decrease) in body mass index.

A summary of baseline and 12-month results can be found in Table 3.3. The results of the paired t-test yielded a significant decrease in hemoglobin A1c (p<0.05), systolic blood pressure (p = 0.01), LDL cholesterol (p<0.01), total cholesterol (p<0.05) and total cholesterol: HDL ratio (p<0.05) over twelve months. A significant increase in HDL cholesterol (p<0.05) was also noted. No significant difference in BMI, diastolic blood pressure or triglycerides was reported at twelve months. Complete results of the paired sample t-test are reported in Appendix D.
Table 3.3 Participant Characteristics in an Intensive Multifactorial Diabetes Intervention at Baseline and Twelve Months (mean ± SD)

<table>
<thead>
<tr>
<th></th>
<th>0 months</th>
<th>12 months</th>
<th>p-value</th>
<th>CDA † CPG</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI (kg/m²) (n = 70)</td>
<td>33 (7)</td>
<td>33 (7)</td>
<td>0.720</td>
<td>----</td>
</tr>
<tr>
<td>Systolic blood pressure (mm Hg)(n = 70)</td>
<td>131 (18)</td>
<td>126 (16)</td>
<td>0.010</td>
<td>≤130</td>
</tr>
<tr>
<td>Diastolic blood pressure (mm Hg)(n = 70)</td>
<td>76 (10)</td>
<td>75 (9)</td>
<td>0.545</td>
<td>≤80</td>
</tr>
<tr>
<td>Hemoglobin A1c (%) (n = 70)</td>
<td>8.53 (1.70)</td>
<td>7.41 (1.80)</td>
<td>0.000</td>
<td>≤7.0</td>
</tr>
<tr>
<td>HDL cholesterol (mmol/L) (n = 29)</td>
<td>1.13 (0.23)</td>
<td>1.20 (0.24)</td>
<td>0.016</td>
<td>≥1.04‡</td>
</tr>
<tr>
<td>LDL cholesterol (mmol/L) (n = 28)</td>
<td>3.00 (0.78)</td>
<td>2.50 (0.80)</td>
<td>0.009</td>
<td>≤2.5</td>
</tr>
<tr>
<td>Triglycerides (mmol/L) (n = 29)</td>
<td>1.94 (0.98)</td>
<td>1.90 (1.25)</td>
<td>0.814</td>
<td>≤1.5</td>
</tr>
<tr>
<td>Total Cholesterol (mmol/L) (n = 29)</td>
<td>4.94 (1.08)</td>
<td>4.37 (1.17)</td>
<td>0.042</td>
<td>≤4.14‡</td>
</tr>
<tr>
<td>Total Cholesterol:HDL Ratio (n = 24)</td>
<td>4.50 (0.98)</td>
<td>3.93 (1.22)</td>
<td>0.016</td>
<td>≤4.0</td>
</tr>
</tbody>
</table>

† CDA, 2003
‡ Genest et al., 2003

3.1.3 Evaluation of Achievement of Clinical Targets for Glycemic Control

**Hypothesis 2:** Participants undergoing the intensive multifactorial clinical intervention will achieve clinical practice guidelines for hemoglobin A1c at the end of the twelve month intervention.

A comparison of between-group values for hemoglobin A1c at baseline and twelve months can be found in Figure 3.1. Overall, 52.9% \((n = 37)\) of participants met the clinical practice guidelines for hemoglobin A1c at the end of the twelve month evaluation period and 47.1% \((n = 33)\) of patients did not. An independent t-test revealed that both
groups had similar glycemic control at baseline (i.e. no significant difference was detected) (Figure 3.1). Additionally, all participants had baseline hemoglobin A1c values greater than 7.0%.

Figure 3.1 Glycemic Control of Participants in an Intensive Multifactorial Diabetes Intervention at Baseline and Twelve Months (mean ± SEM)

* <p < 0.05, ** <p < 0.01 compared to baseline

3.1.4 Identification of Predictors of Glycemic Control

Hypothesis 3: Age, pharmacological therapy, smoking status, frequency of visits, self-monitored blood glucose testing, disease duration at baseline will be significant
predictors of glucose control over twelve months. Gender will not have a significant
effect.

Based on preliminary analysis, only significant predictors (disease duration and
continuity of care) were entered in the final model (Table 3.4). Disease duration was
presented in years as a continuous variable. Continuity of care was presented as a
continuous variable in terms of the frequency of physician visits per year.

The model (Table 3.4) indicated that disease duration and frequency of visits
significantly predicted achievement of glycemic control at twelve months (achieved or
not achieved). Thus patients who had increased disease duration and had more frequent
physician visits were less likely to achieve glycemic targets at twelve months. The overall
model for predicting achievement of glycemic targets at twelve months was significant
(p<0.01) according to the model chi-square statistic ($\chi^2 = 15.42$ (df=2)). The model was
able to correctly predict achievement of glycemic control at twelve months in 67.1% of
cases. The model summary is reported in Appendix E.

Disease duration variable had a Wald statistic of 7.61 (p = 0.01). The associated
odds ratio was 0.90, thus with a one year increase in disease duration patients were 0.90
times (10%) less likely to achieve glycemic control at twelve months (95% CI Exp(B) =
0.831 - 0.969, p = 0.01).

Continuity of care variable had a Wald statistic of 5.77 (p = 0.02). The associated
odds ratio was 0.25, thus with every one visit increase in continuity of care, patients were
0.25 times (75%) less likely to achieve glycemic control at twelve months (95% CI

\[ \text{Exp}(B) = 0.079 - 0.773, p = 0.02 \]. The regression equation can be found in Appendix F.

Table 3.4. Predictors of Glycemic Control in an Intensive Multifactorial Diabetes Intervention at Twelve Months

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>SE</th>
<th>Wald</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease Duration**</td>
<td>-0.108</td>
<td>0.39</td>
<td>7.61</td>
<td>0.90</td>
</tr>
<tr>
<td>Continuity of Care*</td>
<td>-1.398</td>
<td>0.582</td>
<td>5.77</td>
<td>0.25</td>
</tr>
</tbody>
</table>

*p < 0.05, **p < 0.01

3.2 Discussion

The findings of the current study were threefold. First, the study showed that the clinical intervention at the Diabetes Clinic was successful, resulting in a statistically and clinically significant improvement on a number of outcomes related to diabetes management. Second, over half of the patients enrolled in the clinical intervention obtained hemoglobin A1c values that met clinical targets for glycemic control in Type 2 diabetes. Third, the study identified two factors (disease duration and continuity of care) as significant predictors of glycemic control in individuals enrolled in a community-based intensive multifactorial intervention for Type 2 diabetes. Collectively these findings should provide valuable information for health care practitioners designing future interventions for people with Type 2 diabetes.

The current study findings showed that patients experienced a significant improvement in the following parameters over a twelve month period: hemoglobin A1c, systolic blood pressure, HDL-cholesterol, LDL-cholesterol, total cholesterol and total cholesterol:HDL ratio over twelve months. No significant difference in BMI, diastolic blood pressure or triglycerides was reported over twelve months. The results of large
population-based studies, such as the UKPDS, have demonstrated that the achievement of glycemic targets through intensive diabetes therapy using sulfonylureas, biguanides or insulin resulted in a 25% reduction in microvascular complications (UKPDS Group, 1998). Moreover, for every 1% decrease in glycated hemoglobin level, the risk of microvascular complications decreased by 35%, diabetes-related death decreased by 25% and all-cause mortality decreased by 7% (UKPDS Group, 1998). Although risk reduction for macrovascular complications was observed in the UKPDS, the results were not statistically significant (UKPDS Group, 1998). Therefore, the greater than one percent decrease in hemoglobin A1c observed in this cohort over time is clinically significant (UKPDS, 1998; UKPDS, 1999). In previous multifactorial clinical interventions for Type 2 diabetes which implemented intensive management of hypertension and dyslipidemia in addition to hyperglycemia, an absolute 20% reduction in the risk of cardiovascular events was reported as well as a 50% reduction in cardiovascular disease and microvascular disease (Gaede et al., 2003). Although we cannot isolate the effect of improvement in each of these individual biomedical outcomes, these findings suggest that the improvement in hypertension and dyslipidemia observed in the present study may also be clinically significant (The DCCT Research Group, 1993; UKPDS, 1998; UKPDS, 1999). Given the lack of control group, we are not able to attribute change in any of these parameters or lack in change to the clinical intervention in place at the Diabetes Clinic. However, the noted improvement in most biomedical outcomes presents promising evidence to support the implementation and effectiveness of community-based intensive
multifactorial clinical interventions and also supports previous findings related to intensive multifactorial interventions in Type 2 diabetes.

A number of studies have reported findings consistent with the results of the present study and noted significant improvement in metabolic outcomes over time among patients enrolled in an intensive diabetes intervention, regardless of the methods used to achieve these targets (Gaede et al., 2003; Ménard et al., 2005; UKPDS Group, 1998; UKPDS Group, 1999). At the end of the 7.8 year Steno-2 study, both intensive and conventional groups improved significantly over time on each of the following parameters: glycosylated hemoglobin, fasting plasma glucose, fasting serum lipid concentrations, systolic and diastolic blood pressure, and urinary albumin excretion rate (Gaede et al., 2003). However, those in the intensive group improved to a greater degree than those in the conventional group. The differences between the two groups were consistent and maintained throughout the 7.8-year follow-up period. Ménard and colleagues (2005) reported similar findings. These findings suggest that diabetes therapy, whether conventional (not driven by clinical targets in the normal range) or intensive (driven by clinical targets in the normal range), will lead to improvements in biomedical outcomes. Although, Gaede et al. (2003) and Ménard et al. (2005) noted improvement in most clinical outcomes over time, one should note that some biomedical outcomes evaluated in the previous studies did not improve. This observation remains consistent with the findings of the present study.
One of the biomedical factors related to the management of diabetes and prevention of related complications interpreted in this study was obesity. In the current study, no improvement (decrease) in BMI values was noted at twelve months. However, an increase in BMI was observed albeit nonsignificant. This finding is consistent with previous literature. In the study by Ménard and colleagues (2005), those undergoing the intensive intervention did not experience an improvement in BMI but rather experienced a significant increase in body weight and thus BMI. In a number of other studies, researchers have noted that patients undergoing intensive insulin therapy achieve improvement in glycemic profile with a concurrent increase in body weight (Purnell, Hokanson, Marcovina, Steffes, Cleary & Brunzell, 1998; Yki-Järvinen, 2001). Given the role of overweight in the development of insulin resistance and Type 2 diabetes (Bogardus, 2000), the achievement of glycemic control with concurrent weight gain would seem to be counterproductive. Intuitively, insulin resistance should improve with weight loss and not weight gain as observed in patients undergoing intensive insulin therapy. However, researchers have noted that intensive insulin therapy halts hyperglycemia-induced wasting of energy in the form of glucosuria and in the overproduction of glucose (Bogardus, Taskinen, Zawadzki, Lillioja, Mott & Howard, 1986) and when glucose control improves, energy loss in the urine decreases or ceases and thus weight increases (Bogardus et al., 1986; Franssila-Kallunki & Groop, 1992).

Previous research related to improvements in glycemic control with concomitant weight gain allows one to interpret the findings related to BMI as follows. Participants in
This study had poor glycemic control at baseline; however, it may not have been sufficiently poor to warrant significant weight gain after one year of intensive treatment (Yki-Järvinen, 2001). Additionally, previous investigation of the relationship between glycemic control and weight gain (Yki-Järvinen, 2001; Mäkimattila, Nikkila & Yki-Järvinen, 1999) was limited to conventional intensive insulin therapy, not intensive multifactorial therapy. A multifactorial approach to intensive diabetes therapy, which includes dietary and physical activity components as well as additional management of diabetes outcomes such as hypertension and dyslipidemia, may counter the effects of weight gain observed in previous studies related to intensive diabetes management (Siminerio, 2006). Additionally, only 11.4% of participants in this study were prescribed insulin only pharmacologic treatment. Thus, this sample may not be representative of populations previously evaluated with respect to the relationship between weight gain and the achievement of glycemic control in patients since they were undergoing intensive diabetes therapy with insulin only.

In addition to BMI, the present study also evaluated the lipid profile and showed improvement in the majority of its components. Analysis of the lipid profile revealed improvement on all parameters but triglyceride levels. This finding is consistent with the literature which reports that when patients engage in recreational physical activity participation, make appropriate dietary changes and comply with lipid lowering pharmaceutical therapy, HDL cholesterol levels should increase and LDL-cholesterol, triglycerides and total cholesterol:HDL ratio should decrease (Beckman, Creager &
Libby, 2002). Each of these behavioural components is part of the intensive multifactorial approach to Type 2 diabetes therapy. Current intensive multifactorial diabetes interventions have also noted improvement in these lipid parameters (Gaede et al., 2003; Ménard et al., 2005). In the Steno-2 study, marked improvement was noted in LDL cholesterol, total cholesterol and triglyceride levels within the first year among those in the intervention group. Ménard and colleagues (2005) also noted a significant improvement in triglycerides and total cholesterol:HDL ratio, however, LDL cholesterol remained unchanged.

One interesting finding with respect to the lipid profile was the lack of improvement in triglyceride levels – these levels did decrease however the change was not significant. This is not consistent with findings of previous intensive multifactorial interventions where patients experienced significant improvement (decrease) in triglyceride levels over twelve months (Gaede et al., 2003; Ménard et al., 2005). A possible explanation for this inconsistent finding could be related to the number of participants included in the statistical analysis should also be noted. Data related to lipid profile was severely limited and included readings for twenty four of seventy patients included in the study. Thus the findings related triglycerides and other components of the lipid profile may not be truly representative of the sample. Additionally, this study did not assess the impact of pharmacologic agents, lipid lowering or other, on the lipid profile. According to a Medline search (1966–2000) of published articles comparing pharmacologic treatment (insulin alone vs. combined therapy) in Type 2 diabetes, insulin
alone lowers serum triglycerides slightly more than insulin combination therapy (Yki-Järvinen, 2001). Given the high proportion of participants who were prescribed combined OHA and insulin therapy, the potential decrease in triglycerides may be less than anticipated than with insulin therapy alone (Yki-Järvinen, 2001). In terms of the physiological mechanisms, increased triglycerides in people with Type 2 diabetes are due to a direct increase in VLDL production and decreased triglyceride catabolism due to decreased lipoprotein lipase activity (Haffner, Mykkanen, Festa, Burke & Stern, 2000). Therefore, the underlying physiologic mechanisms that lead to hypertriglyceridemia in people with Type 2 diabetes may also limit the amount of improvement that can be achieved.

The lack of improvement in triglyceride level is relevant when considering the relationship between elevated triglycerides and atherosclerosis as well as the high incidence of macrovascular complications in people with Type 2 diabetes. The direct atherogenic effects of triglyceride-rich particles, especially intermediate density lipoproteins (IDL) and remnant lipoproteins, may account for this independent contribution of plasma triglyceride levels to coronary disease risk (Kraus, 1998). Population-based prospective studies have found that for each 1-mmol/l increase in plasma triglyceride there is a 32% increase in coronary disease risk for men and a 76% increase in risk for women (Hokanson & Austin, 1996). Given the high incidence of cardiovascular and peripheral vascular disease in people with Type 2 diabetes, health
professionals and patients should strive to improve triglyceride levels in order to prevent the development of these complications (Krentz, 2003).

Another biomedical outcome examined in the present study was blood pressure. In the present study, the average baseline readings for systolic blood pressure were 131 ± 18 mm Hg and 76 ± 10 mm Hg for diastolic blood pressure. These average blood pressure readings were slightly higher than the CPG for systolic blood pressure (130mm Hg) and below the CPG for diastolic blood pressure (80mm Hg) prior to beginning the intervention (Canadian Diabetes Association, 2003). These blood pressure values are inconsistent with current literature. Previous population-based studies consistently demonstrate that most diabetic patients do not exhibit recommended levels of blood pressure control, and that the majority have a blood pressure >140/90 mmHg (Berlowitz, Ash, Hickey, Glickman, Friedman & Kader, 2003; Chobanian, Bakris, Black, Cushman, Green, Izzo et al., 2003). For example, in the Third National Health and Nutrition Examination Survey (NHANES-III), 31% of all diabetic patients and nearly 60% of those with previously diagnosed hypertension had a blood pressure >140/90 mmHg (Harris et al., 1998). Among elderly diabetic patients seen in an academic medical center, 85% had a blood pressure ≥130/85 (Chin, Su, Jin & Nerney, 2000).

The discrepancy between previously observed population-based data related to hypertension in people with Type 2 diabetes and the findings of the present study may be explained by a number of factors. First, all patients assessed at the Diabetes Clinic were seen on a referral basis by a family physician. Therefore, all hypertensive patients were
almost certainly previously diagnosed and treated by the family physician. Scientific evidence also suggests that although blood pressure control is difficult to achieve in people with Type 2 diabetes, patients are more likely to attain clinical targets for systolic and diastolic blood pressure than hemoglobin A1c (Hiss, 1996). Additionally, patients referred to the Diabetes Clinic may not have had concomitant hypertension to begin with, although this is highly unlikely given the previously stated incidence of hypertension in this population. This finding suggests that the achievement of blood pressure control is possible in a population of patients with Type 2 diabetes and may not be as unlikely as suggested by larger population-based studies (Harris et al., 1998).

Although patients in the present study displayed baseline blood pressure levels that met the recommendations of the 2003 CDA CPGs, participants still experienced a significant improvement in systolic blood pressure \( p = 0.010 \) at the end of the twelve month period. Diastolic blood pressure remained unchanged. The improvement in systolic blood pressure over time is consistent with current scientific literature. In terms of improvement over time, patients enrolled in intensive multifactorial interventions such as the Steno-2 and the study by Ménard and colleagues (2005) all reported a significant improvement in systolic blood pressure values after one year of therapy. However, the findings of these previous studies did not report improvements in systolic blood pressure levels that were as remarkable as those in the present study. The greater improvement in systolic blood pressure levels observed in the present study may be explained by changes
in diet therapy, exercise participation and antihypertensive pharmacologic treatment; however these were not measured in the current study.

The systolic blood pressure findings of the current study are promising for several reasons. In individuals younger than fifty years, diastolic blood pressure is a better predictor of future complications of hypertension, whereas in those fifty years and older, systolic blood pressure is a better predictor of future complication risk (Franklin, Larson, Khan, Wong, Leip, Kannel et al., 2001). Given the average age of the participants, 58.3 ± 11.1 years, the improvement in systolic blood pressure observed in this cohort is clinically relevant. Regardless of the means used to achieve significantly lower systolic blood pressure levels at the end of the twelve month intervention (diet, exercise, pharmacologic), scientific evidence suggests that the improvements reported in the present study will reduce the incidence of hypertension-related complications such as cardiovascular disease (UKPDS Group, 1999). Systolic hypertension remains a much more important cardiovascular disease risk factor than diastolic hypertension in older persons (those aged ≥60 years) (Chobanian et al., 2003; Sagie, Larson & Levy, 1993; O'Donnell, Ridker, Glynn, Berger, Ajani, Manson et al., 1997). In addition to the macrovascular complications, hypertension in people with diabetes is also the major contributing factor to the development of microvascular complications (UKPDS Group, 1998; Berlowitz et al., 2003; Hansson et al., 1998). Therefore, the improvements in systolic blood pressure reported in this study may lead to increased years of life among patients in this cohort as well as improved quality of life.
In summary, patients in the present study exhibited a significant improvement in the majority of biomedical outcomes relevant to the prevention of microvascular and macrovascular complications (glycemic control, lipid profile and blood pressure). Although this intervention has been deemed effective, these findings do not indicate the actual feasibility of achieving clinical practice guidelines for these outcomes as defined by the Canadian Diabetes Association.

The second purpose of the present study was to examine whether participants enrolled in the intensive multifactorial clinical intervention would achieve clinical practice guidelines for hemoglobin A1c at the end of the twelve month intervention. Overall, 52.9% (n = 37) of participants met the clinical practice guidelines for hemoglobin A1c at the end of the twelve month evaluation period. This finding is consistent with previous literature which indicates that some individuals undergoing an intensive multifactorial clinical intervention, but not all, will be able to achieve clinical targets for glycemic control (Gaede et al., 2003; Ménard et al., 2005).

In previous studies such as the project by Ménard and colleagues (2005), 35% of participants enrolled in an intensive multifactorial clinical intervention achieved the CPG for hemoglobin A1c at twelve months. Additionally, these researchers reported that a significantly higher number of patients in the intensive treatment group met the clinical targets for hemoglobin A1c at twelve months compared to those who underwent conventional therapy (goal ≤7.0%: 35% v. 8%). The Steno-2 study also reported comparable findings (Gaede et al., 2003). Although the improvement in glycosylated
hemoglobin over time in the Steno-2 study was significantly greater in those undergoing intensive therapy, there was no significant difference in the number of participants who met clinical targets ($P = 0.06$). Given the Danish hemoglobin A1c target of 6.5% (Gaede et al., 2003), a significantly greater proportion of participants in the intensive treatment group may have met the Canadian guidelines of 7.0%. Even though some participants in the present study did not achieve clinical targets for glycemic control at twelve months, these findings support the feasibility of implementing CPGs for hemoglobin A1c in a community setting and indicate that a greater proportion of patients in this intervention were able to achieve the defined clinical targets. The increased proportion of patients who achieved the CPG for glycemic control may be explained by a number of factors such as lifestyle, baseline glycemic control and pharmacologic therapy.

In terms of lifestyle, increased physical activity participation may explain the increased proportion of patients who achieved the CPG for glycemic control. Although the intervention at the Diabetes Clinic did not include a specific physical activity program, it is plausible that the patients in the present study had increased exercise levels compared to those in the Steno-2 study (Gaede et al., 2003), the study by Ménard and colleagues (2005) or in the UKPDS (UKPDS Group 1998). However, information related to exercise participation was not recorded in the present study and we are thus unable to further examine this possibility. In addition to physical activity, dietary counseling may also explain the increased proportion of patients who achieved the CPG for glycemic control. Patients were referred to diet counseling based on need and
progression through the Stages of Change behavioural model (Prochaska & DiClemente, 1982). Counseling was conducted by the dietitian at the Diabetes Clinic or by a dietitian in the health region; however the overall frequency at which dietary counseling took place was not recorded in the patient chart. Given the inconsistent documentation of dietary counseling, the impact of this factor on the achievement of CPG for glycemic control was not explored any further.

In addition to lifestyle factors, the increased number of participants who achieved glycemic targets at twelve months may also be explained by factors inherent to this cohort, specifically baseline hemoglobin A1c. Hemoglobin A1c values were lower at baseline in this study than those observed in the Steno-2 study (Gaede et al. 2003) and the study by Ménard et al. (2005). Previous attempts by family physicians to achieve control of blood glucose levels may explain these lower baseline values. In turn, the lower baseline values may have resulted in more likely achievement of hemoglobin A1c at twelve months. In addition to the better baseline glycemic values, other factors such as pharmacologic therapy should be considered.

Another possible explanation for the difference in CPG achievement in the present study may be the approach to pharmacologic therapy. Although the present study and others (Gaede et al., 2003; Ménard et al., 2005) implemented a similar approach to prescription of hypoglycemic pharmacologic treatment among patients, there are a number of extrinsic factors that could have influenced the protocol implemented. For example, it is possible that the physician in the present study was required to deviate from
pharmacologic prescription protocol in special circumstances such as drug intolerance or adverse side effects (Gaede & Pederson, 2004). Depending on the alternative pharmacologic agent, this deviation from prescription protocol could have led to either an increased or decreased likelihood of achieving glycemic control.

Although one cannot explain why an increased proportion of participants in this cohort were able to achieve clinical targets for glycemic control, these findings are relevant to the implementation of future CPGs in a community setting. These findings suggest that the CPGs that were derived by the Canadian Diabetes Association are attainable in community practice. This is extremely important for physicians treating patients in the community where rigorous controls are not in place. Although more than half of the participants were able to achieve glycated hemoglobin values less than 7.0% after twelve months, ultimately all patients should be able to achieve these targets. In order to accomplish this feat, it is essential to have a better understanding of factors that facilitate the achievement of glycemic control.

Understanding the factors involved in the achievement of glycemic control was the essence of the third purpose of the present study. Specifically, the study question explored the impact of the following factors on glycemic control at twelve months: age, gender, pharmacologic therapy, smoking status, frequency of clinical visits, self-monitored blood glucose testing and disease duration. Only the significant predictors (disease duration and continuity of care) were entered in the model.
Overall, increased disease duration was associated with a decreased likelihood of attaining clinical practice guidelines for hemoglobin A1c. This finding is supported by previous research. In a study by Chan and colleagues (2000), disease duration was positively correlated with glycosylated hemoglobin and was an independent determinant of glucose control. Similar findings were reported by Benoit and colleagues (2005). These findings are not unlikely given the pathogenesis of Type 2 diabetes. Through the progression of Type 2 diabetes, one would assume that increasing insulin resistance and eventual β-cell failure would render glycemia more difficult to control (Bogardus, 2000; Flakoll et al., 2000; Kahn & Flier, 2000). Therefore, increased disease duration translates to poor glycemic control and the decreased likelihood of achieving clinical targets for hemoglobin A1c in a community-based intensive multifactorial intervention. However, there are also other factors that may explain this finding.

For example, individuals who have recently been diagnosed with diabetes may be more vigilant in developing mechanisms to ensure appropriate glycemic control over those living with diabetes for an extended period of time. These mechanisms may include factors such as dietary control, increased compliance with pharmacologic agents, increased physical activity participation and improved self-monitored blood glucose practices. Given the limitations of the current data set, it is impossible to further explore these possibilities. In order to further understand the factors that are associated with the achievement of glycemic control in patients undergoing a community-based intensive
multifactorial clinical intervention, one must also recognize the impact of continuity of care.

The second factor examined, continuity of care, was found to be a significant predictor of glycemic control. In the current study, patients who saw the physician more often were less likely to achieve glycemic targets at twelve months. Although the research related to continuity of care is limited, these findings are inconsistent with the limited published literature.

Currently, there are few publications addressing how the frequency of physician visits affects disease outcomes (DeSalvo, Block, Muntner, & Merrill, 2003). Additionally, the most optimal visit frequency for achieving optimal outcomes in patients with chronic diseases has yet to be defined (DeSalvo et al., 2003). Among children with Type 1 diabetes, Kaufman et al. (1999) found that glycemic control correlated with increasing visit frequency to their clinic. Those patients seen three to four times per year had lower mean hemoglobin A1C than those seen one to two times per year (Kaufman et al. 1999). Among adults, Weinberger and colleagues (1996) demonstrated that increased access to primary care increased the rate of re-hospitalizations for veterans with chronic disease, including diabetes. Conversely, Smith et al. (1987) intervened in adults with diabetes to increase clinic visit frequency, but were unable to demonstrate an impact on utilization and hospitalizations. Although the findings related to glycemic control and physician re-visit interval are inconsistent, the findings related to the present study may be explained by certain factors.
According to the findings of the present study, patients who were assessed more often were less likely to achieve glycemic targets at twelve months. It can thus be inferred that patients with poorly controlled glucose levels will be assessed more often. It is unclear if patients who are assessed more often will improve over time if given a longer intervention period or if they will continue the trend of poorly managed glycemia (DeSalvo et al., 2003). A longer intervention period would be required in order to reveal this trend. Although glycemic control is influenced by continuity of care, it appears that the assignment of future visits by physicians is also influenced by a number of factors which were not examined in the present study (DeSalvo et al., 2003).

The findings of the current study revealed that of the factors that were examined (i.e. age, gender, disease duration, pharmacologic treatment, diabetes self care, continuity of care and smoking status); only disease duration and continuity of care were significant predictors. This would suggest that factors other than those examined may also predict glycemic control in people with Type 2 diabetes. Harris and colleagues (1998) examined the impact of racial and ethnic differences in glycemic control in patients with Type 2 diabetes using the Third National Health and Nutrition Examination Survey (NHANES III). This group of researchers reported that black women, Mexican-American men, those treated with insulin or oral hypoglycemic medications, and patients over sixty years of age had suboptimal glycemic control when examined at a given point in time. It is unclear whether or not these factors are associated with achievement of glycemic targets in a twelve month intensive multifactorial intervention. In a similar study assessing
predictors of glycemic control, increased body mass index (BMI) and increased emotional distress were examined and identified as significant predictors of poor glycemic control (Rosilio, Cotton, Wieliczko, Gendrault, Carel, Couvaras et al., 1998). Other factors such as increased C peptide levels, poor self-care, and failure to receive diet recommendations have also been linked to poor glycemic control (Blaum et al., 1997). These findings from previous research suggest that a great number of factors may predict glycemic control.

In summary, the results of the present study indicate that disease duration and continuity of care are significant predictors of glycemic control in patients enrolled in a community-based intensive multifactorial clinical intervention for Type 2 diabetes. However, researchers must continue to identify other factors that are associated with glycemic control in order to further improve the approach to diabetes care and to better understand the needs of the patient population (Benoit et al., 2005). Retrospective databases such as the one used in the present study provide researchers with the unique opportunity to further investigate other factors (Engberg, Christensen, Karlmose, Lous, & Lauritzen, 2002).

A retrospective design is one that looks back on outcomes or events that have already taken place. In order to ensure that the most accurate information is extracted from a study that uses a retrospective approach, it is important to recognize strengths and limitation of the retrospective study design (Concato, Shah & Horwitz, 2000). In terms of the strengths of retrospective projects, several have been recognized with respect to the
evaluation of clinical practice (Engberg et al., 2002; Benson & Hartz., 2000).

Retrospective databases allow researchers to examine medical care utilization as it occurs in routine clinical care (Benson & Hartz., 2000). Additionally, these databases usually provide large study populations and longer observation periods, allowing for examination of specific subpopulations. In terms of cost and feasibility, retrospective databases also provide a relatively inexpensive and expedient approach for answering the time-sensitive questions asked by health care professionals (Engberg et al., 2002).

One of the most common research methods used to examine routine clinical practice is the chart audit. The chart audit is deemed an acceptable method of examining routine clinical practice and measuring physician performance (Jennett & Affleck, 1998). The chart audit was thus used to examine the research questions in the present study. Given the advantages of this retrospective research method, chart audits have been previously used in a number of population-based studies to examine a variety of research questions (Jennett & Affleck, 1998).

Although the data set at the Diabetes Clinic provided an excellent overview of the clinical practices that were undertaken, certain parameters were documented in less detail and thus limited the analysis of the proposed research questions. For example, the patient information related to physical activity participation and related counseling was severely limited. Thus, these parameters as well as those related to specific dietary recommendations and habits could not be included as we would have liked.
According to Motheral and colleagues (2003), an appropriate interpretation of a retrospective study is only possible if the key attributes of the patient population are described, including the sociodemographic and health care profile of the population and limitations on the available health care services. As previously stated, patients who attended the Diabetes Clinic were diagnosed with a variety of metabolic disorders including Type 1 diabetes, Type 2 diabetes, thyroid disorders and Cushing's Disease. Only the patients with Type 2 diabetes were included in this study. This study unfortunately did not collect information on patient ethnicity, personal income or access to private health insurance. Although access to health services did not appear to be limited, access to appropriate pharmaceutical care was. Based on the experience of the practicing physician at the Diabetes Clinic, a number of patients in this cohort did not have coverage through a private drug plan and thus opted not to purchase the prescribed drug therapy. These descriptive findings provided greater insight into the patients observed in this study and the population as a whole.

In order to ensure that the information retrieved from the chart review was both valid and reliable, it was essential to ensure that precautionary measures were in place. According to Motheral and colleagues (2003), certain measures need to be taken to ensure the reliability and validity of the data included in a retrospective study. Quality assurance checks were necessary to determine the reliability and validity of retrospective data in the present study (Benson & Hartz., 2000; Motheral et al., 2003). The reliability and validity of the data are not static attributes of a given database but can vary.
dramatically depending on the questions asked and analyses performed (Benson & Hartz., 2000; Motheral et al., 2003). Quality checks are particularly important with administrative databases from health care providers because the data was originally collected for purposes other than research, most often for billing purposes and clinical follow-up (Benson & Hartz, 2000; Motheral et al., 2003). Examples of important quality checks include missing values, out of range values, and consistency of data (e.g., patient age) (Motheral et al., 2003). In the present study, each of these quality assurance checks was performed for the dataset from the Diabetes Clinic. Only data that met the quality assurance check was included in the study. For example, the final analysis did not include data on waist circumference or microalbumin since less than 10 observations were recorded. Additionally, researchers concluded that physical activity participation data retrieved from the charts was severely limited and could not be interpreted in a meaningful manner. Therefore, data related to physical activity participation was not included in the study. In addition to this limitation of the data set, the greatest limitation of this study was the inability to identify a control group.

One of the major limitations of this project was the lack of control group. If researchers attempt to make inferences about a particular intervention, a design in which there is no comparison or control group is rarely adequate (Motheral et al., 2003). Without a comparison group (persons non-exposed to an intervention), there often exist too many potential biases that could otherwise account for an observed “treatment” effect (Motheral et al., 2003). However, the purpose of this study was to examine the overall
effectiveness of a community-based intervention, to examine the feasibility of implementing CPGs for glycemic control in a community setting and to examine the factors that predict the achievement of glycemic control at the end of a twelve month intervention. Since the information retrieved from the dataset was sufficient to fulfill these objectives, the research design adopted in this study was deemed adequate.
CHAPTER 4
CONCLUSIONS

4.1 Conclusions

In conclusion, the findings of the present study showed that this community-based intensive multifactorial intervention for patients with Type 2 diabetes was successful as evidenced by the significant improvement in participant glycemic control, systolic blood pressure and all parameters of diabetic dyslipidemia but triglyceride levels. This finding supports the translation of research into clinical practice and concludes that the implementation of intensive multifactorial interventions can be effective in a community-based setting. Therefore, health professionals should strive to implement similar intensive multifactorial interventions in community practice in order to improve the prognosis of their patients and decrease the likelihood of diabetes-related complications.

With respect to the achievement of the 2003 CDA CPGs, over half of the participants met clinical targets for glycemic control at twelve months. Therefore, the implementation of CPGs related to glycemic control is feasible a community-based setting. However, efforts should be made to ensure that all patients achieve the clinical targets for glycemic control, blood pressure and diabetic dyslipidemia. The achievement of CPGs for glycemic control, blood pressure and diabetic dyslipidemia will reduce the onset of microvascular and macrovascular complications in this population thus improving the patient’s quality of life and long term prognosis. Additionally, a decrease
in diabetes-related complications will reduce the economic burden of Type 2 diabetes on
the Canadian health care system.

Based on the evaluation of predictors of glycemic control in this study, baseline
disease duration and continuity of care (frequency of physician visits) were significant
predictors of glycemic control twelve months. Thus, health professionals should focus on
these particular variables when designing multifactorial clinical interventions in order to
identify patients with particular challenges related to diabetes management and to
develop resources that will better meet patient needs. For example, health care
professionals should design specific interventions for patients with increased disease
duration, thus addressing the barriers related to the achievement of glycemic control in
this specific patient group.

4.2 Future Research

In order to truly develop the best community-based intensive multifactorial
clinical intervention, further research examining the predictors of glycemic control is
necessary. However, current literature related to the prediction of glycemic control is
limited to American data and has yet to define these factors in a consistent manner
(Benoit et al., 2005; Blaum et al., 1997; Weinberger et al., 1996). A Canadian
population-based study should be conducted in order to evaluate factors that are
predictive of glycemic control. Specifically, additional research should assess the impact
of return visit intervals on outcomes for a variety of disease states so that quality
improvement initiatives can adequately address the variation in practice patterns (Chapko,
Fisher & Welch, 1999). Research should also attempt to examine other physician habits and their impact on clinical outcomes.

Although this study evaluated the effectiveness of a community-based intensive multifactorial clinical intervention in patients with Type 2 diabetes, additional research should include a prospective randomized control study in order to provide between-group comparisons and truly evaluate improvement over time. Furthermore, research should be undertaken to identify the individual influence of each of the interventions (pharmacologic, diet, physical activity) that occur concurrently in a multifactorial clinical intervention (Gaede et al., 2003). Given the limited budget that many clinics and health districts must work with, the identification of the impact of the individual interventions would enable health care professionals to concentrate their professional efforts and financial resources in the areas that prove to be most effective for patients (Gaede et al., 2003). This is particularly important in diabetes interventions where most patients will become long-term participants.

In order to ensure that community-based intensive multifactorial clinical interventions remain effective over time, a longitudinal evaluation of the biomedical and behavioural parameters addressed in the current study should also be conducted. Studies such as the UKPDS have indicated that biomedical outcomes, particularly glycemic control, tend to deteriorate over time (UKPDS Group, 1999). A longitudinal intervention would also allow health care practitioners to identify whether or not the achievement of CPGs for glycemic control is feasible in a greater proportion of patients if given
sufficient time (Ménard et al., 2005). The long-term follow-up of patients enrolled in a community-based intensive multifactorial intervention should also track the onset and progression of diabetes-related complications and relate the incidence of complications to the achievement of glycemic control (Gaede et al., 2003) and the impact of these complications on the patient’s quality of life (Ménard et al., 2005).
REFERENCES


APPENDIX A

2003 Canadian Diabetes Association Clinical Practice Guidelines
**2003 Canadian Diabetes Association Clinical Practice Guidelines**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Target</th>
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<tbody>
<tr>
<td>Hemoglobin A1c</td>
<td>&lt;7.0%</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>&lt;130/80 mm Hg</td>
</tr>
<tr>
<td>LDL cholesterol</td>
<td>&lt;2.5 mmol/L</td>
</tr>
<tr>
<td>Total cholesterol: HDL ratio</td>
<td>&lt;4.0 mmol/L</td>
</tr>
<tr>
<td>Triglycerides*</td>
<td>&lt;1.5 mmol/L</td>
</tr>
</tbody>
</table>

* Current evidence does not support specific targets for triglycerides but the optimal triglyceride level is <1.5 mmol/L.
APPENDIX B

Diabetes Clinic Patient Summary – Initial Assessment
**SASKATOON HEALTH REGION**
Saskatoon, Saskatchewan
**ST. PAUL’S HOSPITAL DIABETES CLINIC**
655-5575/5578

**ASSESSMENT**

<table>
<thead>
<tr>
<th>Diabetic No.</th>
<th></th>
</tr>
</thead>
</table>

Name: ___________________________ Gender: ___ DOB: _________________

Address: _______________________________________________________

Tel. No.: ___________________ Email: ___________________ FAX: ___________

Date of Entry: ___________ Occupation: ____________________________

Referral Source: __________________________

**History:**

**Diagnosis of diabetic:** Type 1 ☐ Type 2 ☐ Gestational ☐ Other ☐

Date of diagnosis: ___________ Age at diagnosis: _______________________

Mode of presentation at diagnosis: ______________________________________

Present complaints: ___________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

**Systems Enquiry:**

Any visual change: Yes____ No_____ Date of last ophthalmologist visit: ___________

Polyuria ☐ Nocturia ☐ Dysuria ☐ Yeast infection ☐

Angina: ___________ Dyspnea: ___________ TIA: ___________ Claudication: ___________

Leg pain ☐ Burning ☐ Numbness ☐ Tingling ☐

Bladder dysfunction ☐ Gustatory sweating ☐ GI symptom ☐ Incontinence ☐

Dizziness on standing ☐ Erectile function ☐

Details: ____________________________________________________________

<table>
<thead>
<tr>
<th>Form#</th>
<th>Approval Date</th>
<th>Form Category</th>
</tr>
</thead>
</table>
ST. PAUL'S HOSPITAL DIABETES CLINIC
ASSESSMENT

Skin and foot:

Fill in the following blanks with an "R", "L", or "B" to indicate positive findings on the right, left, or both feet.

- Has there been a change in the foot since last evaluation? Yes  No
- Is there a foot ulcer now or a history of foot ulcer? Yes  No
- Does the foot have an abnormal shape? Yes  No
- Is there weakness in the ankle or foot? Yes  No
- Are the nails thick, too long or ingrown? Yes  No

Psychosocial stressors:

Recent infections:

Family History: Diabetes Mellitus  IHD  Dyslipidaemia
- Hypertension  Kidney disease  Infertility/hirsutism
- Autoimmune disease  Other

Details:

Past History: Endocrine  Infection  IHD  Surgery  Other

Details:

Concomitant Medications:

Obstetric History: Parity  Still birth  Spontaneous Abortion
- Macrosomia  Congenital Abnormalities  Diabetes in pregnancy  PIH

Details:

Gynecological History: LNMP:  Contraception:  AUB:

Menopausal Symptoms:

Risk factors: Hypertension  Dyslipidemia  Central Obesity
- Cigarette Smoking

Details:
ST. PAUL'S HOSPITAL DIABETES CLINIC
ASSESSMENT

Lifestyle:
Nutritional History:
   Breakfast:______________________________
   Lunch:_______________________________
   Supper:______________________________
   Snacks:______________________________
   Likes and dislikes:________________________
   Alcohol:______________________________

Physical Activity:______________________________________________

Allergies:_____________________________________________________

Diabetes Education received: Yes ☐ No ☐

Monitoring: 1) Is testing/not:______________________________
   2) Did not bring log book:______________________________
   3) Testing: frequency____________________________________
       Times in relation to meals:_________________________
   4) Log average: B_______ L_______ D_______ HS_______

Medications:

Insulin

<table>
<thead>
<tr>
<th></th>
<th>AM</th>
<th>Noon</th>
<th>PM</th>
<th>Bedtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>R/H</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPH/L/UL</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Oral

<table>
<thead>
<tr>
<th>Glyburide/Glipizide/Gliclazide</th>
<th>AM</th>
<th>Noon</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metformin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rosiglitazone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acarbose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glucomon</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Episode of hypoglycemia:__________________________________________

Episode of Diabetic Ketoacidosis:_________________________________

Social: Education_______________________________________________

   Employment________________________Medical Insurance____________

   Economic Factors__________________Medic Alert___________________
ST. PAUL’S HOSPITAL DIABETES CLINIC
ASSESSMENT

Physical Examination

Height: _____  Weight: _____
BMI: _____  Waist: _____
Skin: _____  Dyslipidemia: _____  Injection sites: ________________
Thyroid: _____  Feature of 2º cause of diabetes: ________________
Oral cavity: ________________  Hands: ________________
Other: ________________
Chest: ________________
Pulse: 

<table>
<thead>
<tr>
<th></th>
<th>Carotid</th>
<th>Brachial</th>
<th>Radial</th>
<th>Femoral</th>
<th>Popliteal</th>
<th>PT</th>
<th>DP</th>
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<tbody>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

BP: Lying ______  Standing ______  JVP ______  Bruits: ______
Praecordium: ________________
Abdomen: ________________
NS: Cognitive ________________
Psychiatric ________________
Cranial nerve: ________________
Motor: Muscle Wasting ❑  Fasciculation ❑

Power & Tone: 

<table>
<thead>
<tr>
<th></th>
<th>Shoulder</th>
<th>Elbow</th>
<th>Wrist</th>
<th>Hips</th>
<th>Knee</th>
<th>Ankle</th>
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<tbody>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td></td>
<td></td>
<td></td>
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</table>

Reflexes: 

<table>
<thead>
<tr>
<th></th>
<th>Biceps</th>
<th>Triceps</th>
<th>Supinator</th>
<th>Knee</th>
<th>Ankle</th>
<th>Plantar</th>
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<tbody>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td></td>
<td></td>
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</table>

Sensation: 

<table>
<thead>
<tr>
<th></th>
<th>Light Touch</th>
<th>Pain</th>
<th>Proprioception</th>
<th>Vibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ST. PAUL'S HOSPITAL DIABETES CLINIC
ASSESSMENT

Eyes: Pupils reactive
Extraocular movement
Lens opacities
Fundus:

Foot: In circled areas indicate sensation to monofilament (I = sensate; - = non-sensate)

Nails: ___________________________
Callosity: _______________________
Bunion: Y/N
Maceration: _____________________
Plantar Ulceration: Y/N
Location: ________________________
Diameter: ________________________
Charcot Foot: Y/N
Prominent Metatarsal Heads: Y/N

Draw in: Callus Q Ulcer N (note width/depth in cm)

And Label: Skin condition with R - Redness, S - Swelling, W - Warmth, D - Dryness, M - Maceration

Vascular: Brachial Systolic Pressure
Ankle Systolic Pressure
Ischemic Index

Does the patient use footwear appropriate for his/her category? Yes ___ No _____

RISK CATEGORY: The University of Texas Diabetic Foot Risk Classification System

<table>
<thead>
<tr>
<th>Category</th>
<th>Recommendation</th>
<th>Follow up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 0: No Neuropathy</td>
<td>Education</td>
<td>6-12 months</td>
</tr>
<tr>
<td>Category 1: Neuropathy, No Deformity</td>
<td>Education/hose gear</td>
<td>3-4 months</td>
</tr>
<tr>
<td>Category 2: Neuropathy with Deformity</td>
<td>Pedorthist consult/Prophylactic surgery</td>
<td>2-3 months</td>
</tr>
<tr>
<td>Category 3: History of Pathology</td>
<td>Pedorthist consult/Prophylactic surgery</td>
<td>1-2 months</td>
</tr>
<tr>
<td>Category 4A: Neuropathic Wound</td>
<td>Wound care program</td>
<td>Weekly</td>
</tr>
<tr>
<td>Category 4B: Acute Charcot's Joint</td>
<td>Non-weight bearing</td>
<td>Weekly</td>
</tr>
<tr>
<td>Category 5A: The Infected Diabetic Foot</td>
<td>Incision &amp; drainage/Antibiotics</td>
<td>Hospital</td>
</tr>
<tr>
<td>Category 5B: The Ischemic Limb</td>
<td>Vascular consultation</td>
<td>Monthly</td>
</tr>
</tbody>
</table>
ST. PAUL'S HOSPITAL DIABETES CLINIC
ASSESSMENT

Assessment:

Investigations:

Management
1) Diet

2) Physical Activity

3) Medications

4) Counselling

Self Monitoring  

<table>
<thead>
<tr>
<th>Hypoglycemia</th>
<th>Sick days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Targets:

- HLAIC:
- Lipid:
- Bp:
- Glucose levels:

5) Other
March 2004

Dr.
Medical Clinic
Saskatoon, SK S

RE: Date of Visit: March /04

New Problems:

Glucose Control:

Current Medications:

Lifestyle:

Feet: OK.

Fingers:

PHYSICAL EXAMINATION

Weight: kg  BP: Pulse:

INVESTIGATIONS:

MANAGEMENT SUGGESTIONS

Sincerely,

DICTATED - NOT READ

Dr. S. Juta, F.C.P.
Diabetes Clinic
Arm

TOTAL: P. 21
APPENDIX D

Statistical Analysis: Paired Sample T-test
### Statistical Analysis: Paired Sample T-test

**Paired Samples Correlations – 0 and 12 Months**

<table>
<thead>
<tr>
<th>Pair</th>
<th>Metric</th>
<th>N</th>
<th>Correlation</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1</td>
<td>BMI</td>
<td>70</td>
<td>0.979</td>
<td>0.000*</td>
</tr>
<tr>
<td>Pair 2</td>
<td>Weight</td>
<td>70</td>
<td>0.975</td>
<td>0.000*</td>
</tr>
<tr>
<td>Pair 3</td>
<td>Systolic Blood Pressure</td>
<td>70</td>
<td>0.610</td>
<td>0.000*</td>
</tr>
<tr>
<td>Pair 4</td>
<td>Diastolic Blood Pressure</td>
<td>70</td>
<td>0.596</td>
<td>0.000*</td>
</tr>
<tr>
<td>Pair 5</td>
<td>Hemoglobin A1C</td>
<td>70</td>
<td>0.299</td>
<td>0.012*</td>
</tr>
<tr>
<td>Pair 6</td>
<td>HDL-cholesterol</td>
<td>29</td>
<td>0.813</td>
<td>0.000*</td>
</tr>
<tr>
<td>Pair 7</td>
<td>LDL-cholesterol</td>
<td>28</td>
<td>0.300</td>
<td>0.121</td>
</tr>
<tr>
<td>Pair 8</td>
<td>Triglycerides</td>
<td>29</td>
<td>0.814</td>
<td>0.000*</td>
</tr>
<tr>
<td>Pair 9</td>
<td>Total cholesterol</td>
<td>29</td>
<td>0.192</td>
<td>0.006*</td>
</tr>
<tr>
<td>Pair 10</td>
<td>Total cholesterol/HDL Ratio</td>
<td>24</td>
<td>0.546</td>
<td>0.319</td>
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</tbody>
</table>

* Correlation is significant at the 0.05 level.

### Single Sample Dependent T-test

<table>
<thead>
<tr>
<th></th>
<th>Confidence Intervals</th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Lower</td>
<td>Upper</td>
<td>t-score</td>
<td>df</td>
<td>Sig (2-tailed)</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>-0.39351</td>
<td>0.27335</td>
<td>-0.35946</td>
<td>69</td>
<td>0.720348</td>
</tr>
<tr>
<td>n = 70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>-0.99946</td>
<td>0.996602</td>
<td>-0.00286</td>
<td>69</td>
<td>0.99773</td>
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<td>n = 70</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic blood pressure (mm Hg)</td>
<td>1.178421</td>
<td>8.307293</td>
<td>2.654485</td>
<td>69</td>
<td>0.009853*</td>
</tr>
<tr>
<td>n = 70</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Diastolic blood pressure (mm Hg)</td>
<td>-1.46575</td>
<td>2.751467</td>
<td>0.608204</td>
<td>69</td>
<td>0.545049</td>
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<tr>
<td>n = 70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemoglobin A1C (%)</td>
<td>0.617727</td>
<td>1.60513</td>
<td>4.491052</td>
<td>69</td>
<td>0.0277*</td>
</tr>
<tr>
<td>n = 70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDL cholesterol (mmol/L)</td>
<td>-0.12381</td>
<td>-0.01412</td>
<td>-2.57586</td>
<td>28</td>
<td>0.015568*</td>
</tr>
<tr>
<td>n = 29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDL cholesterol (mmol/L)</td>
<td>0.137937</td>
<td>0.862063</td>
<td>2.833529</td>
<td>27</td>
<td>0.008605*</td>
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<tr>
<td>n = 28</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triglycerides (mmol/L)</td>
<td>-0.24409</td>
<td>0.308226</td>
<td>0.237873</td>
<td>28</td>
<td>0.813712</td>
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<td>n = 29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Cholesterol</td>
<td>0.02163</td>
<td>1.10940</td>
<td>2.130</td>
<td>29</td>
<td>0.042</td>
</tr>
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<td>n = 29</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Total Cholesterol/HDL Ratio (mmol/L)</td>
<td>0.118112</td>
<td>1.015222</td>
<td>2.613368</td>
<td>23</td>
<td>0.015537*</td>
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<tr>
<td>n = 24</td>
<td></td>
<td></td>
<td></td>
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</table>
APPENDIX E

Model Summary for Binomial Logistic Regression Analysis
Model Summary for Binomial Logistic Regression Analysis

<table>
<thead>
<tr>
<th>-2 Log Likelihood</th>
<th>Cox &amp; Snell R Square</th>
<th>Nagelkerke R Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>81.395 (a)</td>
<td>0.198</td>
<td>0.264</td>
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</table>
APPENDIX F

Logistic Regression Equation
## Logistic Regression Equation

### Variables in the Equation

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>Sig.</th>
<th>Exp(B)</th>
<th>95.0% C.I. for Exp(B)</th>
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<tbody>
<tr>
<td>Disease duration</td>
<td>-0.108</td>
<td>0.039</td>
<td>7.606</td>
<td>1</td>
<td>0.006</td>
<td>0.897</td>
<td>0.831 - 0.969</td>
</tr>
<tr>
<td>Frequency of visits</td>
<td>-1.398</td>
<td>0.582</td>
<td>5.773</td>
<td>1</td>
<td>0.016</td>
<td>0.247</td>
<td>0.079 - 0.773</td>
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<tr>
<td>Constant</td>
<td>4.019</td>
<td>1.370</td>
<td>8.602</td>
<td>1</td>
<td>0.003</td>
<td>55.624</td>
<td></td>
</tr>
</tbody>
</table>

### Regression Equation

\[
\text{Log (Hb A1c <7.0\% at 12 months)} = B_0 + B_{\text{disease duration}} (X) + B_{\text{frequency of visits}} (X)
\]

\[
\text{Log (Hb A1c <7.0\% at 12 months)} = 4.019 - 0.108(\text{disease duration}) - 1.398(\text{frequency of visits})
\]