Chapter 5
Discussion

This study was conducted to identify the various factors associated with poor control of type 2 diabetes mellitus and to derive a statistical model to predict poor control of diabetes, at the initial stage of the disease.

5. A. Factors associated with poor control of type 2 diabetes: A systematic review

The results of the systematic review showed that age < 60 years and abnormal BMI had poor control. Male gender had better control over the disease. Smoking habit, presence of depression, increase in SBP or DBP, duration of diabetes, medication compliance, fatty liver, foot problems, insulin use, and metformin use were not associated with poor control of diabetes.

Presence of diseases such as: CHD, neuropathy, retinopathy, renal failure, neurological disorders were associated with poor control of diabetes. Non adherence to diet, non adherence to exercise, and intake of oral drugs were associated with poor control of diabetes. Use of Insulin, and metformin were not associated with poor control of diabetes.

This discrepancy may be due to the fact that poorly controlled diabetes may change adherence to diet and exercise, and take multiple oral drugs to avoid insulin therapy. However at that particular stage of poor control, those modifications and oral drugs may not hold.
5. B. Physician’s perception about the determinants of poor control of type 2 diabetes

The physicians were agreed that C-peptide, age, diastolic blood pressure, presence of hypertension, presence of nephropathy, insulin treated diabetes, and systolic blood pressure, as factors associated with poor control of diabetes.

Few of the physicians, disagreed that reluctance to prescribe insulin, and number of drugs prescribed as risk factor for poor control of diabetes.

In patients with cardiovascular disease and elder age subjects may not opt for intensive glucose control for fear of hypoglycemia and onset of nephropathy. With chronic kidney disease may decrease insulin requirements and patient may achieve good glycemic control.

On an open ended question it was cleared that, some of the important aspects of diabetes control such as: knowledge, attitude and practice regarding the disease and its complications, and role of primary care physicians, which could leads the diabetes poorly controlled.

Encouraging educational programs, which emphasize lifestyle modifications, with more emphasis on family support is very important to mange poor control of diabetes. Primary care physician has an important role in glycemic control.
5. C. A statistical model for predicting poor control of type 2 diabetes mellitus

The results of our study showed that male gender, younger age, habit of smoking, habit of alcohol consumption, lack of exercise, absence of hypertension, and absence of neuropathy were associated with poor control of diabetes.

The risk of poor control was 2.21 times more for male gender than female. Smokers and alcoholics had the risk of poor control 1.19 and 1.33 respectively. However the diabetics with lack of exercise had the risk of poor control 3.37 times than subjects with adequate exercise. The gender difference that we found was contrary to previous studies were male gender was associated with better glycemic control.

There was no association between subjects with weight loss, family history of diabetes, coronary heart disease, nephropathy, diet compliance, exercise compliance, drug compliance and poor control of diabetes. On univariate analysis, there was no difference in mean age, weight, BMI, waist circumference, age at onset of disease, total calorie intake, SBP, DBP, cholesterol level and triglycerides between the poorly controlled and controlled diabetics. The findings from this study were compared with the findings of other studies conducted on type 2 diabetics. Some of the comparisons are:

Men were more likely than women to achieve diabetes better controlled (52% vs 43.6%; P < 0.001). The rates of hypertension, and vascular complications were higher in subjects with poorly controlled diabetes than in those with better controlled (69.9% vs 55.7%, and 21.8% vs 8.9%; P < 0.001). Coronary heart disease among the two groups was: 18.7% vs 17.3%; P > 0.05.
Glycated hemoglobin was positively correlated with age ($P = 0.013$), disease duration ($P < 0.001$), insulin resistance ($P < 0.001$), and negatively with BMI ($P < 0.001$). HbA1c was higher among smokers ($8.9\%$ vs. $8.2\%; P = 0.003$).

Subjects with poor glycemic control had higher incidences of diabetic peripheral neuropathy, and fatty liver than those with better controlled ($46.0\%$ vs $35.0\%$, and $36.9\%$ vs $25.3\%; P < 0.01$). There was no differences in the incidences of diabetic nephropathy ($18.7\%$ vs $16.5\%$), diabetic retinopathy ($30.8\%$ vs $27.4\%$), or diabetic feet ($5.0\%$ vs $3.8\%$) between the groups ($P > 0.05$).

Subjects with low mood or alcohol excess, inadequate blood glucose monitoring, poor exercise or sedentary lifestyle, refusal to take tablets or under dosing, and refusal to take insulin or to increase the dose were associated with poor glycaemic control. Alcohol consumption was linearly ($p < 0.001$) and inversely ($P = 0.001$) associated with HbA1c.

The average age of those who achieved better controlled diabetes was younger than that of those who were in poorly controlled diabetes ($63.2\%$ vs $64.5\%; P < 0.001$). LDL cholesterol was $87.3\%$ vs $82.8\%; P < 0.001$, average LDL cholesterol was lower in the controlled group ($103.1$ vs $109.8; P < 0.001$).

Hyperglycemia was associated with: having diabetes for a longer time (O.R = 2.40; 95% C.I = 1.39 to 4.14), having a first-degree relative with diabetes (O.R = 1.52; 95% C.I = 1.06 to 2.19), and being prescribed anti-diabetic medications, e.g. insulin (O.R = 7.88; 95% C.I = 2.42 to 25.63). Younger age, higher levels of LDL cholesterol, and insulin use were associated with poor blood glucose control.
Men were more likely than women to achieve well-controlled diabetes (52% vs 43.6%; P < 0.001).\textsuperscript{25} The average age of those who achieved well-controlled diabetes was younger than that of those who were in poorly controlled diabetes (63.2% vs 64.5%; P < 0.001).\textsuperscript{25}

Subjects with good adherence to taking medication were more likely to have better glycemic control than those who did not (O.R = 4.63; 95% C.I = 1.04 to 20.60)\textsuperscript{22}. This study identified two variables, which were associated with glycemic control: adherence to diet control, and exercise. There was a negative correlation between HbA1c and:

adherence to: diet (r = -0.16; P < 0.01), exercise (r = -0.16; P < 0.05)\textsuperscript{61}.

Getting well controlled was inversely associated with greater use of medications (P = 0.04), and positively associated with understanding of diabetes (P = 0.03), adherence to recommendations for meal plan (P = 0.001), and glucose monitoring (P = 0.02)\textsuperscript{18}.

Insulin resistance was not sufficient for the development of diabetes in individuals without family history of diabetes\textsuperscript{42}. Personal characteristics explain little of the variation in glycemic control in insulin using adults with type 2 diabetes Mellitus\textsuperscript{42}. Subjects who had diabetes for a longer period of time, used insulin or multiple oral agents, or had high cholesterol were associated with poor glycemic control\textsuperscript{72}.

Multiple oral anti-diabetic agents may serve as a marker for more severe among poorly controlled diabetes. Majority of subjects treated with multiple oral anti-diabetic agents had suboptimal glycemic control and suggested that there was a need for intensified efforts to treat this particular group of subjects to achieve good glycemic control\textsuperscript{34}.
Interactive health education should be introduced, to increase patient adherence to treatment regimens\textsuperscript{22}. Lower education levels were associated with poor level of HbA1c\textsuperscript{30}. Self – management practices such as: dieting, exercising, and self – testing of glucose were given strong emphasis in diabetes management and thereby disease gets controlled and it supports the suggestions from physicians that, change in life style is a factor for poor control of diabetes\textsuperscript{23}.

Previous studies had found conflicting results on factors associated with poor glycemic control. This may be explained by the differences in study design, characteristics of the study population, and the types of treatment facilities. Differences in race and ethnicity of the studied population, dosages of oral drugs or insulin, compliance with regimens, self monitoring of blood glucose and socio economic status may lead to greater improvement in glycemic control. Socio economic status may influence diabetes management and control since it is often associated with access to health care, healthcare utilization, use of medication and access for good nutrition.

In this study, every unit increase in age, BMI, waist circumference had influence on poor control of diabetes. Control of diabetes was poor among male gender. Smoking habit, alcohol consumption, and lack of exercise will lead to the disease being poorly controlled.

This study identified seven factors, which were associated with poor control of diabetes: age (years), gender (male/female), BMI (Kg/M\textsuperscript{2}), waist circumference (Cm), smoking (yes/no), alcohol (yes/no) and exercise (no/yes).
A logistic regression model was developed by using the identified factors. Overall accuracy of the derived model to predict poor control of diabetes with a predicted probability of 0.50 or greater was 83.4%. Sensitivity was 63%, and specificity was 85%. Positive predictive value was 70%, and negative predictive value was 81%. The area under the ROC curve was 84%.

5. D. A calculator to predict the probability of poor control of type 2 diabetes

This calculator will be helpful to predict the probability of poor control of diabetes based on diabetic’s age (years), gender (male / female), BMI (Kg/M$^2$), waist circumference (Cm), smoking (yes / no), alcohol and exercise (yes / no).

Once the information is entered, the probability of poor control will be calculated automatically. It is very useful for a physician to predict the probability of poor control of diabetes at the time of presentation of subjects to the physician.