Factors Affecting Glycaemic Control among Patients with Type 2 Diabetes Mellitus at Public Healthcare Facilities in the State of Kedah

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Abstract

Introduction: Diabetes mellitus cases continue to rise in Malaysia. With prevalence of 17.5% in 2015, the complexity of treating diabetes with its complication has huge economic impact to the government as Malaysia's healthcare is heavily subsidized.

Objective: The objective of this study was to determine the status of glycaemic control and identify factors associated with good glycaemic control among diabetic patients treated at public healthcare facilities in the state of Kedah.

Methods: This is a retrospective cohort study involving 390 diabetic patients randomly selected from nine hospitals and fourteen health clinics in Kedah. Consented patients were interviewed for their socio-demographic information. Patients' records in healthcare facilities were reviewed for data on laboratory results, complications and co-morbidities. Primary outcome is achievement of HbA1c target.

Results: Univariate analysis showed that glycaemic control was significantly associated with age, use of insulin, type of facility, counselled by pharmacist in the past 1 year, counselled by dietician in the past one year, patients with hypertension, practicing self-monitoring of blood glucose and duration of diabetes. However, multivariable analysis by using multiple logistic regression showed that only 3 factors, which were higher age (OR 0.93, 95% CI: 0.90, 0.97), not receiving insulin (OR 0.16, 95% CI: 0.07, 0.34) and having peripheral vascular disease (OR 0.13, 95% CI 0.03, 0.54) showed significantly better glycaemic control among type 2 diabetes mellitus patients.

Conclusion: Majority of diabetes mellitus patients did not achieve good glycaemic control. These results highlighted the need for appropriate management in diabetes mellitus patients. Besides, more attention should be given to patients prescribed with insulin.

Keywords: Type 2 Diabetes Mellitus, glycaemic control, factors, Kedah state

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Introduction

Diabetes Mellitus (DM) has been a major public health concern globally (1). DM related macrovascular and microvascular complications have significantly increased the burden on health care system. Besides high management cost, these DM related macro- and microvascular complications could also lead to preventable and premature mortality among the patients (2).

In Malaysia, the prevalence of DM has increased two-fold since 1996, with the current prevalence of 17.5% in 2015 (3,4). The total cost of management of diabetes was estimated to be around RM2.04 billion per year for year 2011 (both public and private sector), while nearly 70% was incurred by the government (5). This cost included patient follow-up cost, and cost to treat diabetes related complications such as nephropathy, myocardial infarction, stroke, heart failure, foot amputation, retinopathy and cataract extraction.

Maintaining good glycaemic control has been the shown to prevent the DM related macro- and microvascular complications (6). Strict glycaemic control, which is mainly achieved through adherence to treatment and good self-care behaviours, undeniably plays a pivotal role in DM management (7).

Several measures have been taken including the intervention from physicians (endocrinologist), dietitians, diabetes nurse educators, and pharmacists, for optimization of diabetes care. Lifestyle management, medical nutrition therapy, physical activity pharmacologic management and the use of technologies are some of the components of comprehensive measure which have been taken to manage patient with DM in Malaysia (8). However, many have still failed to achieve good glycaemic control. The reasons and factors that lead to poor glycaemic control are complex and multi factorial (9,10).

According to the National Health and Morbidity Survey (NHMS) 2015, the overall prevalence of DM (known and undiagnosed) among adults of 18 year and above was highest in Kedah State, recorded at 25.4%, compared to other states in Malaysia (3). As to the authors' knowledge, studies on glycaemic control among DM patient in the current region are limited. The aim of this study was to assess the status of glycaemic control and factors affecting glycaemic control in type 2 diabetic patients on follow-up Kedah state public health facilities.

Methods

This cross-sectional study was carried out in the year 2015 in public healthcare facilities in the state of Kedah, Malaysia. The study sites all nine public hospitals and 14 out of 52 public health clinics that were randomly selected. Sample size calculated was 130 samples each from 3 different groups which are hospital with specialist, hospital without specialist and health clinics.

Patients who were diagnosed with Type 2 Diabetes Mellitus (T2DM) for more than 1 year and not receiving any changes in drug regime for past 3 months were included. Patients who defaulted treatment in the past 1 year or referred to other healthcare facilities were excluded from this study. Besides, Gestational Diabetes Mellitus patients or diabetes patients cause by secondary causes such as acromegaly, steroid induced hyperglycaemia, pheochromocytoma (neuroendocrine tumour) or Cushing's Syndrome were also excluded.

This study was approved by the Medical Research and Ethics committee of the Ministry of Health Malaysia. Data such as age, sex, ethnic, BMI, laboratory data, co-morbidities and type of drug used were collected from the patients' medical records. In this study, all consented patients were interviewed using investigator-administered data collection form. The data collection form was developed by the investigators and was divided into two parts, consisting of patients' background, and patients' lifestyle activities, such as smoking status and physical activities. Patients were also asked whether they practiced self-monitoring of blood glucose.

All laboratory outcomes such as HbA1c, cholesterol level and serum creatinine level were based on patient's last medical record within the past three months. Data collected were analysed using the SPSS version 20.0. Logistic regression was used to compare among various factors (demographic factor, laboratory values, co-morbidities and complications) with HbA1c as the outcome.

Results

A total of 390 patients were recruited for this study, where 130 patients were equally selected from hospital with specialist, hospital without specialist and health care centre. The average age of the study population was 59 ± 10 years with 40.8% of male and 59.2% of female. Our population comprised of 79% Malay, 10.5% Indian, 8.7% Chinese and 1.8% of other races. Majority of the patients in our population were married (86.4%, n=337) and 7.7% are widow (n=30). Whilst 4.6% of the study population (n=18) are single and 1.3% divorced (n=5).

Most of our recruited patients received primary (39.7%, n=155) and secondary (44.1%, n=172) education. Only 9.2% (n=36) of our recruited patients did not receive any formal education. Thus, patients in this study are literate. The goals for diabetic patients to healthy lifestyle were to achieve moderate intensity physical activity for at least 150-minute per week. However, only 35.6% of recruited diabetic patients from Kedah did moderate physical activity whereas majority of the population (58.7%) did not have any physical activity. Other demographic data were shown in Table 1.

Table 1: Demographic data according to the types of facility (n=390)

Factor		n	Type of facility			P-value[a]
			Hospital with specialist, n (%)	Hospital without specialist, n (%)	Health clinics, n (%)	
Age						0.019
	<30	5	5 (3.8%)	0 (0%)	0 (0%)	
	31-40	12	7 (5.4%)	2 (1.5%)	3 (2.3%)	
	41-50	53	18(13.8%)	15 (11.5%)	20 (15.4%)	
	51-60	146	49(37.7%)	49 (37.7%)	48 (36.9%)	
	(61 and above)	174	51 (39.2%)	64 (49.2 %)	59 (45.4%)	
Gender						<0.001
	Male	159	72 (45.3%)	44 (27.7%)	43 (27.0%)	
	Female	231	58 (25.1%)	86 (37.2%)	87 (37.7%)	
Race						0.001
	Malay	308	89 (28.9%)	119 (38.6%)	100 (32.5%)	
	Chinese	34	16 (47.1%)	6 (17.6%)	12 (35.3%)	
	Indian	41	22 (53.7%)	3 (7.3%)	16 (39.0%)	
	Others	7	3 (42.9%)	2 (28.6%)	2 (28.6%)	
Marital status						0.006
	Single	18	11 (64.7%)	5 (29.4%)	2 (6.9%)	
	Married	337	114 (33.8%)	110 (32.6%)	113 (33.5%)	
	Widow	30	3 (10.0%)	15 (50.0%)	12 (40.0%)	
	Divorce	5	2 (40.0%)	0 (0 %)	3 (60.0%)	
Level of education						0.001
	No formal education	36	6 (16.7%)	14 (38.9%)	16 (44.4%)	
	Primary	155	37 (23.9%)	58 (37.4%)	60 (38.7%)	
	Secondary	172	74 (43.0%)	53 (30.8%)	45 (26.2%)	
	College & university	27	13 (48.1%)	5 (18.5 %)	9 (33.3%)	
Occupation						<0.001
	Government sector	32	19 (59.4%)	8 (25.0%)	5 (15.6%)	
	Private sector	107	32 (29.9%)	36 (33.6%)	39 (36.4%)	
	Retired	99	51 (51.5%)	23 (23.2%)	25 (25.3%)	
	Student	1	1 (100%)	0 (0%)	0 (0%)	
	Unemployed	151	27 (17.9%)	63 (41.7%)	61 (40.4%)	
Living status						0.499
	Alone	32	5 (25.0%)	9 (45.0%)	7 (30.0%)	
	With family	369	125 (33.9%)	121 (32.8%)	123 (33.3%)	
Household income						0.002
	RM 0-1000	230	65 (28.3%)	85 (37%)	80 (34.8%)	
	RM 1001-2000	73	25 (34.2%)	29 (39.7%)	19 (26.0%)	
	RM 2001-3000	46	18 (39.1%)	5 (10.9%)	23 (50.0%)	
	RM 3001 – 4000	15	7 (46.7%)	4 (26.7%)	4 (26.7%)	
	Above RM 4001	26	15 (57.7%)	7 (26.9%)	4 (15.4%)	
Physical activity						0.028
	Yes – moderate (150min)	139	46 (33.1%)	54 (38.8%)	39 (28.1%)	
	Yes – moderate (90min)	22	13 (59.1%)	4 (18.2%)	5 (22.7%)	
	No	229	71 (31%)	72 (31.4%)	86 (37.6%)	

[a] Chi Square / Fisher's Exact test

Table 2: Characteristics of clinical variable of Type 2 DM patients

Variable	Mean (SD) / Median (IQR)	n (%)
Glycosylated Haemoglobin (HbA1c)	9.09 (2.38) *	
< 7%		80 (22.9)
> 7%		270 (77.1)
Body mass index (BMI)	27.47 (5.30) *	
< 23 kg/m^2		74 (19.0)
> 23 kg/m^2		316 (81.0)
Fasting blood sugar (FBS)	8.88 (4.55) *	
< 4.4 mmol/L		11 (3.0)
4.4-6.1 mmol/L		57 (15.6)
> 6.1 mmol/L		298 (81.4)
Serum cholesterol	4.77 (1.92) *	
< 4.5 mmol/L		123 (34.4)
> 4.5 mmol/L		235(65.6)
Low-density lipoprotein cholesterol (LDL)	3.23(1.05) *	
≤ 2.6 mmol/L		81(28.8)
> 2.6 mmol/L		200(71.2)
Triglycerides (TG)	1.60(0.94) #	
≤ 1.7 mmol/L		164(56.4)
> 1.7 mmol/L		127(43.6)
High-density lipoprotein cholesterol (HDL)	1.17(0.40) #	
≥ 1.1 mmol/L		170(60.5)
< 1.1 mmol/L		111(39.5)
Serum creatinine (SrCr)	75.00 (38.60) #	
< 50		55(14.3)
50-100		239 (62.3)
> 100		90(23.4)

* mean (SD); # median (IQR)
Abbreviation: SD – standard deviation; IQR – inter-quartile range

In this study, only 350 patients out of 390 had HbA1c test done in the past 3 months. The mean HbA1c level was 9.09 % ± 2.38 %. Based on Malaysian Clinical Practice Guideline (CPG) for Type 2 DM management 2015, individualized HbA1c target was set at 6.0%-6.5% for tight control in patients with newly diagnosed DM, younger age, healthier (long life expectancy, no cardiovascular complications) and low risk of hypoglycaemia; 6.6%-7.0% for all others patients and HbA1c 7.1%-8.0% for less tight control in patients with co-morbidities (coronary disease, heart failure, renal failure, liver dysfunction), short life expectancy and prone to hypoglycaemia (11). Hence, patients with HbA1c value ≤ 7 were classifies as good glycaemic control. Other laboratory values were shown in Table 2.

Referring to Table 2, 34.4% (n=123) subjects achieved total cholesterol target of below 4.5 mmol/L. 38.8% (n=47) subjects achieved target cholesterol in hospital with specialist, 40.0% (n=46) subjects achieved target cholesterol in hospital without specialist while 23.8% (n=29) subjects achieved target cholesterol in health clinics. Health clinics recorded the lowest percentage of target cholesterol while hospital with specialist and without specialist recorded almost same percentage. The mean total cholesterol recorded in hospital with specialist was the lowest among all, while health clinics have the highest mean total cholesterol level. Post hoc with bonferroni shown differences between Hospital with specialist and health clinic is significant. P=0.045.

Our study recorded a number of macro and micro vascular complications. For macrovascular complication, 15.3% (n=59) subjects presented with ischemic heart disease, 5.2% (n=20) subjects reported existence of cardiovascular disease and 3.3% (n=13) subjects reported with peripheral vascular disease. 2.1% (n=8) subjects found to have diabetic foot ulcer, and 1.6% (n=6) subjects had amputated before. For microvascular complication, 30.1% (n=116) subjects reported numbness. 36.0% (n=111) subjects had

reported positive proteinuria. 6.0% (n=23) subjects reported non-proliferative retinopathy. No subjects reported Charcot Foot.

High percentage of co-morbidities recorded in our study. Among all, 85.7% (n=329) subjects were diagnosed with hypertension while 72% (n=278) subjects were diagnosed with dyslipidaemia. For counselling session, 46% (n=179) subjects had been counselled at least once by pharmacist, 27.1% (n=105) subjects had been counselled by at least once by dietitian and 18.9% (n=73) subjects had been counselled at least once by diabetic educator.

Body mass index (BMI) was used for the measurement of obesity in this study. The target used was 23 kg/m^2 for Asian population (12). Looking at current results, 17.5% (n=67) subjects achieved BMI < 23 kg/m^2 and 83.5% (n=316) subjects had BMI >23 kg/m^2. The overall mean BMI was 27.47 kg/m^2± 5.30.

In comparing the achievement of target HbA1c between the facilities, 9.6% (n=11) subjects achieved HbA1c ≤7 % in hospital with specialist, 33.9% (n=38) subjects achieved HbA1c ≤7% in hospital without specialist while 25.2% (n=31) subjects achieved HbA1c ≤7% in health clinics in Kedah state. P <0.001. The lowest percentage of HbA1c target achieved was hospital with specialist, while the highest percentage was hospital without specialist. There was a statistically significant difference in favour of the mean HbA1c in different health care facilities. Hospital with specialist recorded mean HbA1c 9.79 % ± 2.27 %. Hospital without specialist recorded mean HbA1c 8.31% ± 2.07. Health clinics recorded mean HbA1c 9.14 % ± 2.46 %. The Bonferroni post hoc tests showed a significant difference (p <0.001) between Hospital with specialist and Hospital without specialist.

Univariate analysis showed that glycaemic control was associated with age (p<0.001), use of insulin (p<0.001), type of facility (p=0.013 and 0.047), counselled by pharmacist in the past 1 year (p=0.001), counselled by dietician in the past one year (p=0.021), patients with hypertension (p=0.011), practicing SMBG (p<0.001), duration of diabetes (p=0.021) and MMAS score (p=0.039) (Table 3). All variables with p-value <0.25 during univariate analysis were then included into multiple logistic regression.

However, multivariable analysis by using multiple logistic regression showed that only 3 factors, which were age, use of insulin and peripheral vascular disease significantly associated with glycaemic control among type 2 diabetes mellitus patients. Results also showed that patients with insulin were having poorer glycaemic control.

Discussion

In this study, 22.9 % subjects (n=80) had achieved HbA1c level below 7.0%, which is classified as good glycaemic control for all other patients based on the above classification by Malaysian CPG. Low level of glycaemic control has been similarly shown in other studies in Malaysia (13). A study on the status of diabetes control in Malaysia showed that Malaysia has poor glycaemic control with only 22% of the patients achieving HbA1c target of < 7% (14), while another study reported only 19.1 % of patients achieving target HbA1c in a tertiary hospital in Kelantan, Malaysia (13).

The higher mean of HbA1c in hospital with specialist might be explained by considering that the patients at the hospital with specialist were generally having more long-standing diabetes, complications and comorbidities and thus less stringent target HbA1c will be applied in the management of those patients. Group with higher risk may experience more severe hypoglycaemia if subjected to too aggressive target HbA1c (15). In Malaysia, the presence of effective referral system between the health clinics, hospital without specialist and hospital with specialist may contribute to the effective referral of patient with poorer glycaemic control to the hospital with specialist for further management.

Higher percentage of DM patients who follow up in hospitals achieved target cholesterol compared to those who follow up in health clinics. This result was found to be similar with a cross-sectional study based on the adult diabetes control and management (ADCM) registry 2009 in Malaysia in which the hospital with specialist recorded a better cholesterol control compared to the health clinics (16). This might be due to the vast availability of anti-cholesterol medication in hospital with specialist compared to health clinic in Malaysia health system.

In terms of BMI, this study found similar result with a recent study of type 2 diabetic patient in Malaysia which recorded only 18.5% of the subjects achieved target BMI at 23 kg/m^2 while 81.5% of the subjects had BMI more than 23 kg/m^2 (17). As reported by study in UK, Southeast Asia is facing the greatest threat of obesity and the increase in the prevalence of type 2 diabetes is closely linked to the upsurge in

obesity. About 90% of type 2 diabetes is attributable to excess weight (18). Thus, there is a great need of fundamental social and political changes in preventing obesity among Malaysian.

For factors affecting glycaemic control, our findings are similar with previous studies that showed older patients tended to achieve better glycaemic control (19-21). Results also showed that patients with insulin have poorer glycaemic control, which is not surprising because diabetes is a progressive disease and patients with diabetes that is not sufficiently controlled with oral hypoglycaemic agents will need insulin to achieve better control. Also, our findings showed that patients with peripheral vascular disease were less likely to have sustained poor glycaemic control, which may be due to the stricter glycaemic targets that were set for those patients.

Contrary to previous study (22-24), duration of diabetes did not significantly associated with glycaemic control in our study. Duration of diabetes was proven not significant in our study when other factors were taken into consideration during multivariable analysis. Perhaps duration of diabetes correlate strongly with other variables such as age or the use of insulin.

The main limitation of the study was unable to measure medication adherence. Besides, Future study can be conducted with proper medication adherence tool.

Conclusion

Only 22.9% of DM patients achieved good glycaemic control. These results highlighted the need for appropriate management in type 2 diabetes patients. Older age and present of vascular disease are factors that showed significantly better glycaemic control among type 2 diabetes mellitus patients. However, patients with insulin were having significantly poorer glycaemic control. Therefore, more attention should be given to patients prescribed with insulin.

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Conflict of interest statement

The authors declare that there is no conflict of interest.

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