

Profiles and Factors Associated with Poor Glycemic Control Among Inpatients with Diabetes Mellitus Type 2 as a Primary Diagnosis in a Teaching Hospital

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ABSTRACT

Context: Diabetes mellitus is a growing health problem in most countries. In Malaysia, there was an increase in prevalence over the years. This makes diabetes also a growing concern in Malaysia, which warrants strengthening of the prevention and control programme. **Aims:** This paper aims to describe the profiles of diabetes mellitus type 2 in tertiary setting and to identify the risk factors for high level of HbA1c among the study population. The findings will give a glimpse on current status of diabetes in our country and may reflect the achievement of the country in combating this disease. **Settings and Design:** A cross-sectional study was conducted in UKM Medical Centre. **Methods and Material:** Medical records of patient with E11 ICD-10 code were collected using Case Report Form. **Statistical Analysis Used:** Descriptive analysis done of mean and median while test of association were done using Spearman correlation and logistic regression. **Results:** The results showed that majority of inpatients of DMT2 showed mean age of 58.8 + 12.6 years and most were males (56.7%) with secondary level of education (41.7%). Median duration of disease was 12.0 + 11.0 years with median HbA1c level of 8.9 ± 4.4%. Only small proportion of patients achieved the desired level of HbA1c <6.5% (21.3%) and significant association was found with tertiary level of education [AOR=0.10, 95%CI=0.01-0.96] and with type of anti-diabetic therapy [AOR=15.90, 95%CI=2.03-124.30]. **Conclusions:** In conclusion, diabetes mellitus type 2 inpatients still showed unsatisfactory glycemic control and holistic approach using health education should be advocated continuously in the future in view of education being one of the predictors for the good HbA1c outcome.

Keywords: Diabetes mellitus type 2 (DMT2), glycemic control, HbA1c

Introduction

Diabetes mellitus is a major health problem in most countries.⁽¹⁾ This chronic condition is a major risk factor

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for heart and cerebrovascular disease and it often co-occurs with hypertension, another major risk factor for chronic problems.⁽²⁾ The World Health Organization had projected that the number of persons diagnosed with diabetes would increase from 135 million in 1995 to 300 million in 2025.⁽³⁾

In Malaysia, the overall prevalence of diabetes mellitus among adults of ≥ 18 years was 15.2%. There was an increase in prevalence as compared to the previous National Health and Morbidity Surveys in 1986, 1996, and 2006. This indicated that diabetes is a growing concern in Malaysia, which warrants strengthening of the prevention and control program. It should be noted that undiagnosed diabetes, which represented the unfelt needs among diabetics, was 8.0%. Moreover, the variability of the estimated observed prevalence by states, the urban population having higher prevalence, the increasing prevalence by age, and higher prevalence in lower educational level groups require various emphases on the allocation of resources provided by the health care delivery systems.⁽⁴⁾

The Ministry of Health has taken major steps to improve the management and care of diabetes patients in its clinics and hospitals by setting up Diabetes Resource Centers in hospitals, training more diabetic nurse educators, making HbA1c test more available, and implementing standardized follow-up protocols. Despite this effort, studies conducted in 1998 to 2003 revealed that the achievement of the goals was far from satisfactory and more should be done to improve the health care personnel's awareness, provide adequate resources, improve patients' diabetes self-management skills, and enhance the patient health care personnel relationship to achieve the goals. In a 2008 study,⁽⁵⁾ it was found that there was a deteriorating glycemc control in patients with diabetes with only 22% of the patients achieving HbA1c of $< 7.0\%$. There was also a high prevalence of complications such as neuropathy, albuminuria, and background retinopathy. As for lifestyle, more than half of the patients were either overweight or obese, and only about half admitted to adhering to a diabetic diet and exercise regularly.⁽⁶⁾

Despite the increasing awareness and the relentless strategies that had been undertaken to control the diabetes epidemic, the disease was still persistently increasing in its prevalence. Therefore, the continuous research on its clinical history and determinants was important to monitor the diabetes evolution over the years. This paper aims to describe the profile of diabetes mellitus type 2 (DMT2) in a tertiary setting and to identify the risk factors for high level of HbA1c in the study population.

Materials and Methods

This was a cross-sectional study using data from medical records of patients admitted to Universiti Kebangsaan Malaysia Medical Centre during the period of January 1, 2013 to December 31, 2013. Ethical approval was obtained from the Ethical Committee of the university.

Patients with DMT2 were defined as: "Patients diagnosed under ICD-10 coding of E-11." The demographics and diabetes clinical profiles were collected using Case Report Form. The inclusion criteria was all patients admitted with primary diagnosis coding of E11 and any patient who had discharged himself/herself at his/her own risk or who did not complete his/her treatment during the time of the study period were excluded.

The outcome of this study was glycemc control. Good control⁽⁷⁾ was defined as having HbA1c level of $< 6.5\%$. Independent variables were patients' demographic and the clinical profiles. Comorbid conditions were defined as either concomitant hypertension or dyslipidemia, or both as diagnosed in the medical records. Diabetes complications that were included were the macrovascular (coronary heart disease, stroke), microvascular (retinopathy, nephropathy), and combination of both; and diabetic foot problems (including peripheral vascular disease, ulcer, neuropathy, and deformity). These complications were also based on the medical records. Management modalities included were lifestyle modification, use of oral antidiabetic medications or insulin, or both.

Descriptive analysis was presented as mean with standard deviation for normally distributed continuous data and as median with interquartile range for data that was not normally distributed. Test of independence was carried out using Pearson chi-square. For categorical relationship, logistic regression was used. The odds ratio with 95% confidence interval and *P* value was presented. The relationships were determined for the independent variables for the control of glycemc prior to admission. All analyses were carried out using Statistical Package for the Social Sciences (SPSS) version 21.0 (Armonk, NY: IBM Corporation).

Results

Demographic and clinical profile

Total admission for DMT2 was 4,954 admissions. Proportion coded as primary diagnosis was only 4.4%. The average length of stay (ALOS) was 13 days for primary diagnosis and 9 days for secondary diagnosis. Table 1 showed the demographics of patients. For glycemc control, patients who achieved good control were only about 21.3%.

Factors associated with high HbA1c (>6.5%)

There was a significant association between poor glycaemic control with the type of antidiabetics management if they were prescribed with combined therapy of oral antidiabetics with insulin injection ($P = 0.027$). Nevertheless, a significant association was not found for the other factors. For the clinical parameters using Spearman correlation, it was revealed that there were significant associations between first, level of HbA1c with age of the patient during admission ($P = 0.014$), second with the level of random blood glucose during admission, and lastly with the level of random blood glucose during discharge ($P = 0.010$). However, no significant relationship was found with the duration of DMT2.

When using the outcome as good or poor control using logistic regression, a significant association was found with secondary education level [odds ratio (OR) = 3.80, 95% confidence interval (CI) = 1.08-13.40] and retinopathy (OR = 0.38, 95% CI = 0.15-0.99). The type of antidiabetic therapy was also found to be significantly associated with the glycaemic control for patients on lifestyle therapy (OR = 8.52 95% CI = 1.47-49.39) as well as for patients on combined oral antidiabetic with insulin injection (OR = 17.33 95% CI = 2.26-132.90). Further analysis using multilogistic regression was shown in Table 2. The model showed that having tertiary education level lowered the risk of being in the poor glycaemic control category [adjusted odds ratio (AOR) = 0.10, 95% CI = 0.01-0.96]. Meanwhile, for the type of antidiabetic therapy used, patients on combined therapy of insulin and oral antidiabetics were found to be at more risk (AOR = 15.90, 95% CI = 2.03-124.30) of having poor glycaemic control. Finally, patients who were discharged with poorly controlled blood pressure of >130/80 mmHg were those who were more likely to be in the group of poor glycaemic control (AOR = 0.20, 95% CI = 0.08-0.72).

Discussion

In this study, the mean age of inpatients with DMT2 was slightly older in comparison with the Diabcare study,⁽⁵⁾

where the mean age was 57.5 years. Furthermore, the study reported that instead of males, females were the majority of patients with DMT2 (51.3%). The different gender pattern may imply that there was an increase of awareness on DMT2 risk factors that were related to the lack of exercise and obesity, which appeared in the majority of women⁽⁵⁾ instead of men, prompting the change of lifestyle among them and therefore, shifting

Table 1: Demographic characteristics of inpatients and association with HbA1c level

| Demographics | Frequency, N (%) | P value |
|--------------------|------------------|---------|
| Age group | 58.75±12.60* | 0.428 |
| 18-39 years | 11 (8.7) | |
| 40-54 years | 30 (23.6) | |
| 55-64 years | 46 (36.2) | |
| >=65 years | 40 (31.5) | |
| Gender | | 0.408 |
| Male | 72 (56.7) | |
| Female | 55 (43.3) | |
| Ethnicity | | 0.104 |
| Malay | 72 (56.7) | |
| Chinese | 36 (28.3) | |
| Indian | 17 (13.4) | |
| Other | 2 (1.6) | |
| Education level | | 0.637 |
| None | 12 (9.4) | |
| Primary | 45 (35.4) | |
| Secondary | 53 (41.7) | |
| Tertiary | 17 (13.4) | |
| Marital status | | 0.350 |
| Single | 6 (4.7) | |
| Married | 103 (81.1) | |
| Divorced | 2 (1.6) | |
| Widowed | 16 (12.6) | |
| Occupation | | 0.395 |
| Government servant | 9 (7.1) | |
| Private employee | 19 (15.0) | |
| Pensioner | 32 (25.2) | |
| Self-employed | 17 (13.4) | |
| Unemployed | 12 (9.4) | |
| Housewife | 38 (29.9) | |

*Mean ± SD, * $P < 0.05$ taken as level of significant

Table 2: Factors associated with level of HbA1c using simple logistic regression and multiple logistic regression

| Variable | Simple logistic regression | | | Multiple logistic regression | | |
|---|----------------------------|-----------------------|---------|------------------------------|-------------|---------|
| | b | Crude OR [†] | P value | b | Adjusted OR | P value |
| Education level | | | | | | |
| Primary | 2.04 | 7.7 | 0.077 | -0.58 | 0.6 | 0.614 |
| Secondary | 1.34 | 3.8 | 0.038* | -0.99 | 0.4 | 0.373 |
| Tertiary | 0.87 | 2.4 | 0.141 | -2.36 | 0.1 | 0.046* |
| Type of complication | | | | | | |
| Retinopathy | -0.97 | 0.4 | 0.049* | 0.567 | 1.8 | 0.454 |
| Type of diabetes medications | | | | | | |
| Dietary/lifestyle | 2.14 | 8.5 | 0.017* | 1.75 | 5.8 | 0.068 |
| Combination of OHA [†] and insulin | 2.85 | 17.3 | 0.006* | 2.76 | 15.9 | 0.008* |

[†]OR: Odds ratio, [†]OHA: Oral hypoglycaemic agent

the burden of disease toward the male gender in the present study. Other than that, the findings showed a similarity with other study^(5,8) whereby most patients were Malays and the majority had secondary level of education (47.8%). The rationale for the ethnicity was that the majority of the population in Malaysia are Malays compared to other ethnicities.

The median duration of diabetes in the present study also showed an almost threefold increase as compared with another study in 2010 in which the median duration was only 4.7 years \pm 4.20 years. It also differed in terms of disease duration whereby the majority of DMT2 patients were those who had the disease for less than 5 years (54.6%) instead of 6-12 years duration. This raised the possibility that patients who had been diagnosed with DMT2 for a longer duration would be more likely to require hospitalization in the future.⁽⁹⁾

Looking at clinical profile, the most commonly associated comorbidity was having concomitant hypertension, which was consistent with a higher prescription of antihypertensive medications. In another study, a similar finding was noted with hypertension (65%) being the most common comorbidity and the most prescribed other medication being antihypertensive (65.9%).⁽¹⁰⁾ Other than that, findings that showed the majority of patients used insulin compared to other therapies that was a contrast to the Diabcare study⁽⁵⁾ in which the majority of the patients were on oral antidiabetic therapy only (73.6%). This might have been due to the changing practice of physicians on prescribing antidiabetic medications and may imply an increased acceptance of patients using insulin as treatment for their diabetes. On the other hand, in view of our study, which took place in a teaching hospital, the budget allocation for prescribed antidiabetics medications may differ from other hospitals causing the data to be skewed toward the usage of insulin as compared to other antidiabetics.

A majority of the patients was noted to have diabetic foot problems in contrast to the ADCM⁽⁹⁾ study in which the majority had the complication of nephropathy (29.0%). This finding may be the result of intensive lifestyle campaign and health promotion, which focus more on cardiovascular improvement technique and these will increase awareness of the importance of exercises; also, there was health promotion to apply dietary changes such as less sugar in food or less consumption of sweetened sugar beverages as examples.

In order to identify the risk factors for having the poor glycemic control during the time prior to hospitalization, HbA1c results were analyzed. Historically, HbA1c was initially identified as "unusual" hemoglobin in patients with diabetes over 40 years ago.⁽¹¹⁾ At present, studies

showed that HbA1c reflects average plasma glucose over the previous 8-12 weeks. It is a preferred test for assessing glycemic control in people with diabetes and has become an essential tool for detecting impaired glucose tolerance for diagnosing diabetes mellitus and for following the adequacy of control in the established disease. The results possibly indicate the risk of complications, particularly microvascular disease in the long term.⁽¹²⁾

In this study, median HbA1c level during admission, when compared with other studies in Malaysia shared similar findings, which were far from the desired level of <6.5%. Furthermore, during admission, it was found that significant association was seen for age and level of random blood glucose taken during admission and discharge. However, due to the limitation of data that were not normal in distribution, the interpretation in terms of direction and the nature of relationship between these parameters was unable to be explored further. However, a study⁽¹³⁾ among outpatients in a tertiary setting found that the duration of diabetes and age were indeed among the significant predictors for glycemic control.

Furthermore, although only a small proportion of patients was seen to achieve good glycemic control, this finding was an improvement in comparison to a previous study⁽¹¹⁾ in the primary care setting (18.1%) and the Diabcare⁽⁵⁾ study (12.9%). However, it may be interpreted as the proportion of showing a good control that had already increased compared to the previous years despite the fact that the majority of patients had still not been able to achieve good control. On a darker note, it might also imply that patients with good glycemic control will be the group to be more likely to be hospitalized though no study yet had been done to verify this hypothesis.

Further analysis showed that although initial analysis revealed the retinopathy was among the significant predictors for being in the poor glycemic control group, after adjustment with other factors studied it was found that it was not a significant predictor for poor control. The result was a contradiction to the earlier Asia-wide study.⁽¹⁴⁾ This can be due to the fact that the earlier study was conducted prospectively and with a bigger study population that had increased the chance to find the causability.

On the other hand, poor control seen during admission was significantly associated with tertiary education level and type of antidiabetic therapy (combination therapy of oral antidiabetics and insulin). For education, having tertiary education was a protective influence on the risk of being in the poor control group in which the people lowered their risk of having poor glycemic control by about 90%. This also reflected that education played an

important role in achieving the desired HbA1c level. There was also evidence, which concluded that a majority of diabetic patients with suboptimal glycaemic control had diabetes-related knowledge deficits, which in turn led to inadequate self-care practices.⁽¹⁵⁾ In Malaysia, the strategy of implementing the diabetic educator in the health care facility is already in place; however, its effectiveness is yet to be evaluated.

In the aspects of types of antidiabetic therapy, patients on combined therapy of oral antidiabetic and insulin injection were found to be at almost three times the risk to be in the poor control group. In contrast to this, according to a study⁽¹⁶⁾ among younger patients of DMT2, patients on insulin were more likely to have poor glycaemic control. It was theorized that it was likely that insulin therapy was introduced in patients who were already poorly controlled due to secondary pancreatic failure, and thus the use of insulin was a result of poor control rather than the cause. Nevertheless, a similar theory can also be implied in this present study.

The strength of this study was that the data were collected in the recent years and thus, might give a glimpse on the current situation of DMT2 in the country. It will be an update to see how the country has progress in combating DMT2. In other words, it will add to the evidence of the DMT2 situation in the country. However, the limitation of this study is that it is nonrepresentative of the whole DMT2 population and for patients not treated in a similar health care setting. Furthermore, as the data were collected retrospectively, the significant risk factors that showed association with the study outcome cannot imply causability. It also means that some parameters such as prior type of management, control, support system, and compliance profile were unable to be explored. Although a significant association was found between study parameters and glycaemic control, the wide 95% CI implied that the findings were not precise in nature, which mandated that these findings to be interpreted cautiously. Other than that, this study shared the other common limitation of retrospective studies whereby some records were not available or some were missing from the archive. However, this last limitation was overcome by a thorough and meticulous data review and transfer by the researcher during the process of data collection.

Conclusion

In conclusion, DMT2 patients showed unsatisfactory glycaemic control despite the implementation of a noncommunicable disease strategy and changing medical practice pattern such as prescribing antidiabetic therapy from oral medication to insulin therapy. Thus, it raises the need for additional approaches to be implemented

to rectify this situation. A holistic approach on health promotion of DMT2 management should be advocated continuously in the future in view of education as one of the significant predictors for HbA1c outcome.

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Conflicts of interest

There are no conflicts of interest.

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