Type 2 Diabetes Mellitus Patient Profiles, Diseases Control and Complications at Four Public Health Facilities- A Cross-sectional Study based on the Adult Diabetes Control and Management (ADCM) Registry 2009

B H Chew, MMed(Fam Med)*, S Shariff-Ghazali, MMed(Fam Med)*,, P Y Lee, MMed(Fam Med)*, A T Cheong, MMed(Fam Med)*, I Mastura, MMed(Fam Med)***, J Haniff, (MPH)****, M A Bujang, BSc(Stat)****, S W Taher, MMed(Fam Med)*****, F I Mustapha,(MPH)******

*Department of Family Medicine, Universiti Putra Malaysia, Serdang, Selangor, Malaysia, ** Institute of Gerontology, Universiti, Putra Malaysia, Serdang, Selangor, Malaysia, *** Seremban 2 Health Clinic, Seremban, Negeri Sembilan, Malaysia , **** Clinical Research Centre, Hospital Kuala Lumpur, Malaysia, ***** Bandar Sungai Petani Health Clinic, Sungai Petani, Kedah, Malaysia, ****** Disease Control Division, Ministry of Health Malaysia, Putrajaya, Malaysia

SUMMARY

Introduction: Diabetes care at different healthcare facilities varied from significantly better at one setting to no difference amongst them. We examined type 2 diabetes patient profiles, disease control and complication rates at four public health facilities in Malaysia.

Materials and Methods: This study analyzed data from diabetes registry database, the Adult Diabetes Control and Management (ADCM). The four public health facilities were hospital with specialist (HS), hospital without specialist (HNS), health clinics with family physicians (CS) and health clinic without doctor (CND). Independent risk factors were identified using multivariate regression analyses.

Results: The means age and duration of diabetes in years were significantly older and longer in HS (ANOVA, p< 0.0001). There were significantly more patients on insulin (31.2%), anti-hypertensives (80.1%), statins (68.1%) and anti-platelets (51.2%) in HS. Patients at HS had significantly lower means BMI, HbA1c, LDL-C and higher mean HDL-C. A significant larger proportion of type 2 diabetes patients at HS had diabetes-related complications (2-5 times). Compared to the HS, the CS was more likely to achieve HbA1c ≤ 6.5% (adjusted OR 1.2) and BP target < 130/80 mmHg (adjusted OR 1.4), the HNS was 3.4 times more likely not achieving LDL-C target < 2.6 mmol/L.

Conclusion: Public hospitals with specialists in Malaysia were treating older male Chinese type 2 diabetes patients with more complications, and prescribed more medications. Patients attending these hospitals achieved better LDL-C target but poorer in attaining BP and lower HbA1c targets as compared to public health clinics with doctors and family physicians.

KEY WORDS:
Type 2 Diabetes Mellitus, Health Facilities, Disease Management, Cardiovascular Diseases, Diabetes Complications

INTRODUCTION

Chronic cardiometabolic diseases comprised about 40% of the total clinical encounters and 20% of the total reasons for encounter at primary care clinics in this country [1]. Based on this survey, public health clinics managed about 3 times more number of patients with these diseases compared to private health clinics (45 versus 15, per 100 encounters respectively) [1]. Even so, the proportion of these diseases at the private general practice had tripled compared to a decade ago [2]. This observation could be attributed to the increasing prevalence of these diseases [3, 4] and increasing role of generalist in diabetes care similarly seen elsewhere [5, 6].

Diabetes care at different healthcare facilities, namely between primary care or general practice (GP) and endocrinologist or diabetologist [7, 8], or between different disciplines of internal medicine within the hospital [9], had been reported. The quality of care across these different healthcare settings varied from significantly better at one setting to no difference amongst them. Hospital specialists tend to perform better in the process measures than the generalists [10], there was no substantial difference in terms of glycaemic and blood pressure control outcomes, particularly after accounting for case mix and physician level clustering [11,12].

This study aimed to elucidate type 2 diabetes mellitus (T2D) patient profiles, disease control and complication rates at four different public health facility categories in Malaysia. Policymakers and stakeholders need to be informed for a better decision in health investment and health care facility planning. The result of this study could help in readjustment of the national healthcare effort and expenditure in fighting the epidemic of diabetes and its complications.

MATERIALS AND METHODS

The data were obtained from the Adult Diabetes Control and Management (ADCM) registry. It represents adult T2D

This article was accepted: 3 July 2013
Corresponding Author: Chew Boon How, Department of Family Medicine, Faculty of Medicine & Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia Email: chewboonhow@gmail.com

patients (≥18 years of age) from 303 public health centres (289 health clinics, 14 hospitals) which contributed a total of 70889 patients from inception of the registry in May 2008 until 31st December 2009. Participation in ADCM was non-mandatory for patients and health centres. All adult patients (≥18 years of age) were informed of the on-going registry and given the opportunity to opt out. Registrations at local centres were generally performed by trained physicians, assistant physicians and nurses. Registration could be done on a paper form or via on-line standard case record form made available in the ADCM website, developed and maintained by Clinical Research Centre (CRC), Ministry of Health, Malaysia. Bigger public health clinics (CS) are situated in cities and towns; have up to 10 medical officers (MO) & family medicine specialists (FMS) and receive 1000 to 2000 clients per day. Smaller public health clinics (CND) are sited in smaller towns and villages; these clinics care for up to 500 clients per day and are manned by paramedics and visited by MO from nearby health clinics on weekly basis. In big hospitals (HS), diabetes care is provided by specialists in internal medicine or endocrinology/ diabetology, registrars, MO and by specialized nurses. However, smaller hospitals at district level (HNS) have only resident MO and visiting specialists from the state-level general hospitals. Further details of this registry and the Malaysian health care system for diabetes patients had been described elsewhere [13,14,15].

Definitions of Clinical Parameters

The definition of T2D was as when their case record fulfilled all these criteria: (i) either documented diagnosis of diabetes mellitus according to the World Health Organization criteria: fasting plasma glucose ≥ 7.0 mmol/L or 2-hour plasma glucose ≥ 11.1 mmol/L[16] and (ii) those whose current treatment consisted of life-style modification, on oral anti-hyperglycaemic agent or insulin. Hypertension was diagnosed if the systolic blood pressure was ≥ 130 mm Hg or the diastolic blood pressure was ≥ 80 mm Hg on each of two successive readings obtained by the clinic physician. Dyslipidaemia is used for either an increase or decrease in concentration of one or more plasma lipids.

HbA1c ≤ 6.5%, HbA1c ≤ 7%, low density lipoprotein-cholesterol (LDL-C) ≤ 2.6 mmol/L, triglyceride (TG) ≤ 1.7 mmol/L and high density lipoprotein-cholesterol (HDL-C) ≥ 1.1 mmol/L were regarded as treatment targets [17, 18]. BMI was calculated as weight divided by height squared and < 23 kgm^2 was taken as the therapeutic target. Blood pressure (BP) recordings were a mean of two BP measurements in the rested position with arm at heart level using a cuff of appropriate size [19]. A BP < 130/80 mmHg was the treatment target. The latest results of these clinical characteristics were used in analyses.

Diabetes complications reported in ADCM were cerebrovascular diseases or transient ischaemic attack (stroke), ischaemic heart disease (IHD), retinopathy, nephropathy and diabetic foot problems (DFP). These complications were retrieved from patients' records. Diagnoses of these complications were made by the attending physicians at the clinics based on the medical symptoms, laboratory results, radiological evidence and treatment history at the clinics and hospitals. Often these diagnoses were informed by the relevant hospital specialists in return referral letter or reported by patient with concordant medication they were prescribed from hospitals. Retinopathy was diagnosed after positive fundus appearance by fundus camera and further confirmed by an ophthalmologist. Nephropathy was diagnosed in the persistent presence (≥ 2 occasions with at least three months apart) of any of the following: microalbuminuria, proteinuria, serum creatinine > 150 mmol/L or estimated glomerular filtration rate < 60mls/min (was calculated using Cockroft-Gault formula). DFP comprised foot deformity, current ulcer, amputation, peripheral neuropathy or peripheral vascular disease.

Statistical Analysis

The independent variables were the four public health facility categories: HS (hospitals with specialist), HNS (hospitals without specialist), CS (health clinics with family medicine specialist) and CND (health clinics without doctor). The independent effect of these health facilities towards each treatment targets was identified using multivariate logistic regression with enter method. The relationship of these variables to the treatment targets were conducted with adjustment for the patient's demography: age, gender, ethnicity, duration of diabetes, BMI, present of co-morbidity, diabetes complications and medication use. These patients' demography and clinical characteristics were considered to be the potential confounders and were further described in our previous reports [20, 21]. We looked into the relationship of health facility categories and each of the disease control grouped as below: glycaemic control represented by HbA1c ≤ 6.5% (1), HbA1c ≤ 7% (1), BP control as < 130/80 mmHg (1), LDL-C ≤ 2.6 mmol/L (1), HDL-C ≥ 1.1 mmol/L and TG ≤ 1.7 mmol/L. Multicolinearity between the independent variables were checked with correlation matrix, inspected of their standard error (SE) magnitude and assumption of Variance Inflation Factor (VIF). We found no variables correlated with each other, r < 0.2, SEs were all within 0.001 to 5.0 and VIF were less than 5.0 [22]. Comparisons of mean levels were performed using the ANOVA and for proportions with the Chi square test. A P value < 0.05 was considered to be significant at two tails. The data were analyzed by using STATA version 9 and PASW 19.0 (SPSS, Chicago, IL).

RESULTS

We had a total of 57780 patients with identifiable site of healthcare facility categories for this study. About 4.5% (2606/57780) of these T2D patients were managed at either hospitals with specialist or without specialists (Table I). Almost 90% (1421/1572) of the T2D patients treated at HS were from the states of Melaka (58.7%) and Negeri Sembilan (31.7%). Almost all T2D patients (1032/1034) seen at the hospitals without specialists were from the states of Pahang (54.4%), Perak (23.2%) and Kelantan (22.1%).

About sixty percent was female. Malay consisted of 61.9%, Chinese 19% and Indian 18%. Table I shows the demography and clinical variables according to the four public health facility categories. Patients seen at HS tend to be older male, have longer diabetes duration and have hypertension or dyslipidaemia. Patients at HS compared to those at CS had significantly lower means for BMI, HbA1c, LDL-C and higher mean for HDL-C. All health facility categories measured BMI more than WC which was much seldom measured in the

Table I: Demography, Clinical Parameters and Treatment Profiles of Type 2 Diabetes patients at the four Public Health Facility Categories, Malaysian Adult Diabetes Registry at 31st December 2009

	Total n (%)	HS, mean (SD)	HNS, mean (SD)	CS, mean (SD)	CND, mean (SD)	χ2/ F Statistic	P value
Total, n (%)	57780 (100)	1572 (2.7)	1034 (1.8)	43100 (74.6)	12074 (20.9)	NA	NA
Age (year)		61.7 (12.83)	58.9 (10.76)	58.1 (11.04)	58.0 (10.87)		
< 30, n (%)		18 (1.1)	5 (0.5)	337 (0.8)	103 (1.1)	61.12	< 0.0001
30-49, n (%)		233 (14.8)	179 (17.3)	8841 (20.5)	2460 (19.9)		
50-69, n (%)		871 (55.4)	664 (64.2)	27246 (63.2)	7586 (57.9)	471.13	< 0.0001
≥ 70, n (%)		450 (28.6)	186 (18.0)	6676 (15.5)	2777 (21.2)		
Female, n (%)	34483 (59.7)	770 (49.0)	607 (58.7)	25576 (59.3)	7530 (62.4)	749.92	< 0.0001
Duration of Diabetes		11.1 (8.68)	6.4 (5.72)	5.9 (5.53)	4.9 (4.62)	605.66	< 0.0001
<5		409 (26.1)	483 (46.9)	21405 (49.9)	6887 (57.3)		
5-9		387 (24.7)	347 (33.7)	14116 (32.9)	3664 (30.5)	1471.02	< 0.0001
≥ 10		771 (49.2)	199 (19.3)	7335 (17.1)	1459 (12.1)		
Ethnicity, n (%)							
Malay		448 (29.3)	699 (67.6)	25021 (58.1)	9634 (79.8)		
Chinese		722 (47.3)	188 (18.2)	9198 (21.4)	1190 (9.9)	2986.92	< 0.0001
Indian		319 (20.9)	137 (13.2)	8497 (19.7)	1068 (8.8)		
Other		38 (2.5)	10 (1.0)	342 (0.8)	179 (1.5)		
Co-morbidity							
Hypertension		1238 (78.8)	755 (73.0)	30337 (70.4)	8329 (69.0)	67.61	< 0.0001
Dyslipidaemia		1056 (67.2)	484 (46.8)	20050 (46.5)	5204 (43.1)	325.97	< 0.0001
BMI		26.3 (4.75)	26.9 (4.77)	27.4 (6.20)	27.1 (5.20)	17.34	< 0.0001
Total, n (%)	53915 (93.3)	1166 (74.2)	1010 (97.7)	40470 (93.9)	11269 (93.3)		
WC (cm)		93.0 (12.27)	94.1 (10.97)	91.8 (11.99)	89.4 (13.12)	59.88	< 0.0001
Total, n (%)	26513 (45.9)	421 (26.8)	233 (22.5)	20436 (47.4)	5423 (44.9)		
SBP (mmHg)		135.0 (19.74)	142.9 (20.69)	136.6 (19.40)	136.8 (19.76)	38.96	< 0.0001
DBP (mmHg)		77.3 (10.33)	80.3 (11.50)	78.5 (10.66)	79.9 (10.46)	71.60	< 0.0001
Total, n (%)	56503 (97.8)	1532 (97.5)	1030 (99.6)	41932 (97.3)	12009 (99.5)		
HbA1c (%)		8.0 (2.17)	8.6 (2.38)	8.3 (2.14)	8.6 (2.32)	48.48	< 0.0001
Total, n (%)	37236 (64.4)	1186 (75.4)	724 (70.0)	27137 (63.0)	8216 (68.0)		
Total cholesterol		4.9 (1.31)	5.4 (1.30)	5.3 (1.20)	5.5 (1.29)	128.75	< 0.0001
Total, n (%)	46289 (80.1)	1193 (75.9)	856 (82.8)	34201 (79.4)	10039 (83.1)		
Triglyceride		1.8 (1.30)	1.9 (1.31)	1.9 (1.23)	2.0 (1.30)	14.33	< 0.0001
Total, n (%)	45717 (79.1)	1041 (66.2)	846 (81.8)	33915 (78.7)	9915 (82.1)		
HDL-C		1.2 (0.37)	1.2 (0.51)	1.3 (0.51)	1.3 (0.52)	26.09	< 0.0001
Total, n (%)	39277 (68.0)	1079 (68.6)	428 (41.4)	29552 (68.6)	8218 (68.1)		
LDL-C		2.9 (1.14)	3.5 (1.13)	3.2 (1.22)	3.3 (1.22)	61.44	< 0.0001
Total, n (%)	38848 (67.2)	1046 (66.5)	369 (35.7)	29271 (67.9)	8162 (67.6)		

cont pg 400

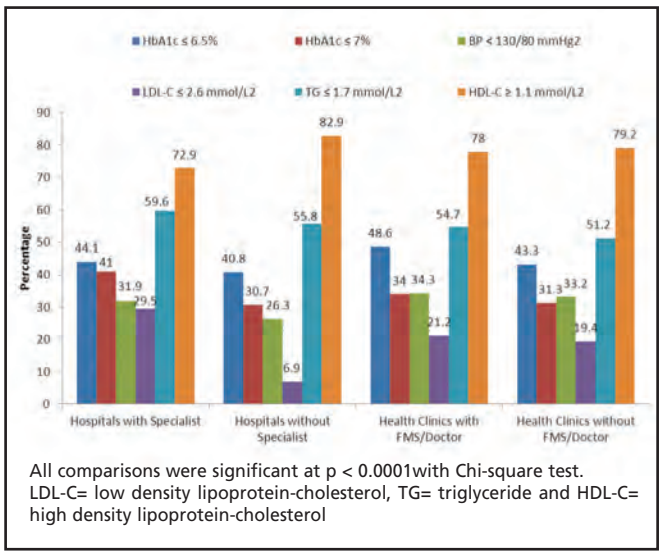
	Total n (%)	HS, mean (SD)	HNS, mean (SD)	CS, mean (SD)	CND, mean (SD)	χ2/ F Statistic	P value
Self-monitoring blood glucose, n (%)	2427 (4.2)	280 (17.8)	22 (2.1)	1893 (4.4)	232 (1.9)	4181.89	< 0.0001
Diet only		90 (5.7)	33 (3.2)	1719 (4.0)	442 (3.7)	17.44	0.001
AHA, n (%)							
Metformin		921 (58.6)	764 (73.9)	33763 (78.3)	9557 (79.2)	365.89	< 0.0001
Sulfonylureas		760 (48.3)	669 (64.7)	28283 (65.6)	8097 (67.1)	218.01	< 0.0001
Acarbose		112 (7.1)	43 (4.2)	1800 (4.2)	656 (5.4)	60.16	< 0.0001
Thiazolidinediones		40 (2.5)	2 (0.2)	37 (0.1)	2 (0)	671.63	< 0.0001
Meglitinides		5 (0.3)	4 (0.4)	124 (0.3)	29 (0.2)	1.28	0.73
Insulin		491 (31.2)	148 (14.3)	5440 (12.6)	985 (8.2)	725.97	< 0.0001
Anti-hypertensives, n (%)							
No		313 (19.9)	258 (25.0)	12844 (29.8)	3869 (32.0)	113.57	< 0.0001
1		515 (32.8)	353 (34.1)	14132 (32.8)	4199 (34.8)	17.35	0.001
2		432 (27.5)	280 (27.1)	10301 (23.9)	2735 (22.7)	26.89	< 0.0001
≥3		312 (19.8)	143 (13.8)	5823 (13.5)	1271 (10.5)	140.22	< 0.0001
ACEI		531 (33.8)	510 (49.3)	19923 (46.2)	5425 (44.9)	103.16	< 0.0001
ARB		283 (18.0)	16 (1.5)	1063 (2.5)	153 (1.3)	1552.03	< 0.0001
Diuretic		350 (22.3)	137 (13.2)	7365 (17.1)	1795 (14.9)	77.70	< 0.0001
CCB		585 (37.2)	297 (28.7)	11389 (26.4)	3000 (24.8)	112.38	< 0.0001
β-blockers		518 (33.0)	329 (31.8)	11327 (26.3)	2911 (24.1)	81 30	< 0.0001
α-blockers		124 (7.9)	66 (6.4)	2044 (4.7)	378 (3.1)	108.56	< 0.0001
Central acting		3 (0.2)	0	187 (0.4)	33 (0.3)	12.12	0.007
Lipid lowering agent, n (%)							
Statin		1071 (68.1)	552 (53.4)	19483 (45.2)	5377 (44.5)	353.62	< 0.0001
Fibrates		92 (5.9)	60 (5.8)	2218 (5.1)	339 (2.8)	123.42	< 0.0001
Anti-platelets, n (%)		805 (51.2)	416 (40.2)	13737 (31.9)	2942 (24.4)	605.27	< 0.0001

All percentages are column percentages except the first row, which is row percentages
χ^2 = Chi-square statistic; F= ANOVA F statistic
HS= hospital with specialist, HNS= hospital without specialist, CS= health clinics with family medicine specialist, CND health clinic without doctor.
WC- waist circumference, SBP systolic blood pressure, DBP= diastolic blood pressure.
LDL-C= low density lipoprotein-cholesterol, TG = triglyceride and HDL-C= high density lipoprotein-cholesterol
AHA= Anti hyperglycaemic agents, ACEI= angiotensin-converting-enzyme inhibitors, ARB= angiotensin receptor blockers.

Table II: Relationship of Health Facilities and Treatment Targets

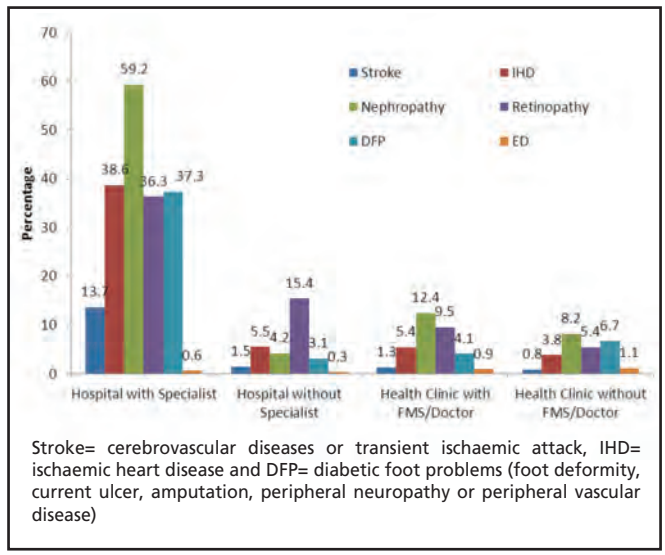
Health Facilities	*OR (95% CI) HbA1c ≤ 6.5%	*OR (95% CI) HbA1c ≤ 7%	*OR (95% CI) BP < 130/80	*OR (95% CI) LDL-C ≤ 2.6	*OR (95% CI) HDL-C ≥ 1.1	*OR (95% CI) TG ≤ 1.7
HS	¶1	¶1	¶1	¶1	¶1	¶1
HNS	0.94 (0.79 to 1.13)	0.58 (0.46 to 0.72)	0.98 (0.78 to 1.22)	0.29 (0.22 to 0.39)	0.74 (0.57 to 0.96)	0.93 (0.75 to 1.14)
CS	1.20 (1.06 to 1.37)	0.67 (0.59 to 0.80)	1.36 (1.17 to 1.57)	1.06 (0.92 to 1.22)	1.12 (0.95 to 1.31)	0.89 (0.76 to 1.04)
CND	0.94 (0.82 to 1.07)	0.89 (0.50 to 0.68)	1.19 (1.01 to 1.39)	1.00 (1.00 to 1.00)	1.01 (1.01 to 1.02)	0.77 (0.66 to 0.91)

Statistically significant results are highlighted in bold.
*Adjusted for age, gender, ethnicity, duration of diabetes, BMI, present of hypertension, present of dyslipidaemia, present of diabetes complication, insulin, anti-hyperglycaemic agents, diet therapy, anti-hypertensive agents, statins and fibrates.
¶1= reference category.
OR= odd ratio, CI= confident interval
HS= hospital with specialist, HNS= hospital without specialist, CS= health clinics with family medicine specialist, CND health clinic without doctor.



All comparisons were significant at p < 0.0001with Chi-square test.
LDL-C= low density lipoprotein-cholesterol, TG= triglyceride and HDL-C= high density lipoprotein-cholesterol

Fig. 1 : Proportion of Clinical Variables controlled to Treatment Targets



Stroke= cerebrovascular diseases or transient ischaemic attack, IHD= ischaemic heart disease and DFP= diabetic foot problems (foot deformity, current ulcer, amputation, peripheral neuropathy or peripheral vascular disease)

Fig. 2 : Proportion of Patient with Complication at each Health Facility

hospitals setting compared to the health clinics (about 25% versus about 45% respectively)(Table I). HNS seemed to rely on total cholesterol and triglyceride assays rather than LDL-C and HDL-C for lipid monitoring (Table I). At HS, there were significantly more patients on insulin (31.2%), anti-hypertensives (80.1%), statins (68.1%) and anti-platelets (51.2%).

Figure 1 shows the proportion of clinical variables that were controlled to targets at each health facilities. Higher proportion of patients achieved HbA1c ≤ 6.5% at the CS, HbA1c ≤ 7% at HS, BP < 130/80 mmHg at CS, LDL-C ≤ 2.6 mmol/L at HS, TG ≤ 1.7 mmol/L at HS and HDL-C ≥ 1.1 mmol/L at HNS. Further descriptive report on demography, clinical characteristics, process measures, treatment modalities and complication rates had been published elsewhere [13]. Figure 2 shows the proportion of T2D patients with diabetes-related complications at each health facilities. A significant larger proportion of patients at HS were having diabetes-related complications (2-5 times).

Compared to HS, after adjusted for covariates, the CS was more likely to achieve HbA1c ≤ 6.5% and BP < 130/80 mmHg (Table II). However, taken at higher targets for HbA1c (≤ 7%), HS was significantly the best compared to the other health facility categories (Table II). HNS was the least likely to achieve LDL-C < 2.6 mmol/L (3.4 times) and HDL-C ≥ 1.1 mmol/L (1.4 times) (Table II).

DISCUSSION

Patient Profiles

This study reported the T2D patients' profile, disease control and diabetes-related complications rates at the four different public health care facilities. We noted that the HS was managing significantly higher proportion of older male Chinese patients with more co-morbidities of longer duration, complications and prescribed more medications such as insulin, ARB, statins and anti-platelets. This was in contrast to the GP and primary care clinics in many Asian [23, 24] and western countries [8, 11] who saw older patients compared to their hospital-based outpatient diabetes clinics. Nevertheless,

hospitals in these countries were also managing more co-morbidities, diabetes-related complications and prescribing more medications as in Malaysia. Perhaps earlier and more aggressive treatment were successful at the early stage of the disease at these health clinics reducing the risk of complications leading to more older patients being managed at their primary care clinics. Hence, it was likely that inadequate control at the earlier part of the disease in our primary care clinics had resulted in high referrals to hospitals later on in life. The presence of effective referral system between our public health clinics and hospitals could be the other reason that the public health clinics were caring for T2D patients who were younger and have shorter duration of diabetes, while those who had more long-standing diseases and complications were being managed at the HS. Therefore, T2D patients at these public health clinics have potential long-term benefits if their diseases could be controlled early[25-27]. Past evidence has indicated that risk of complications could be reduced if diseases are controlled to targets early after diagnosis of diabetes[28].

Treatment Targets

The proportions of patient attained the recommended targets of treatment for glycaemia and BP were better in the CS, whereas the HS had the highest proportion of patients who achieved target LDL-C. There was a similar observation among the GP in the West who were better in glycaemic control and the Asian GP who were better at BP control compared to the hospital-based or tertiary care which was usually better at lipid control[8, 11, 23, 29]. However, glycaemic and BP control were better at public health clinics in this country could be due to its more favourable patients' demographic and clinical profiles which were younger in age, shorter duration of diseases, lesser co-morbidities and complications. Poorer performance in achieving LDL-C target at the clinics could be due to the under usage and restricted availability of anti-lipid agents[19]. Glycaemic and BP control were better at CS as compared to HS after adjusting for patients' demographic and clinical profile posed interesting hypotheses of cost-effectiveness of primary care for T2D such as continuity of care, therapy adherence from more patient activation and participation in decision making which might be absence at HS[30, 31]. These effective principles of family medicine could have made the CND as efficient as the HS except in TG control. The other explanation would be that the older patients at the HS were not treated to HbA1c target of ≤ 6.5% in view of the fact that they were having more long-standing diabetes, comorbidities and complications. This higher risk group patients might experience more severe hypoglycaemia that is detrimental to their health, if subjected to too aggressive anti-diabetic therapy[31]. It was acceptable that this elderly high risk group of T2D patients to have less stringent treatment targets for BP and HbA1c[32]. Further studies need to look into the lack of lipid control, especially the LDL-C control at the HNS. Although CS achieved better hypertension and glycaemic targets (≤ 6.5%) compared to the HS, but the means HbA1c and BPs (both the systolic and diastolic) were actually higher. With patients who were younger and at the early stage of diseases, these rates of control should be better at primary care level in order to achieve more long-term cost-effectiveness in diabetes care[33].

Primary Care for Type 2 Diabetes

Cost-effectiveness studies in developing countries had confirmed that glycaemic control and cardiovascular risk reduction and management, with combination of multidrug regimens, for the prevention of ischaemic heart disease and stroke are achievable[34]. The cost per quality-adjusted-life-year was incremental with age with highest cost-effectiveness of intensive glycaemic, hypertensive and cholesterol control were seen in the younger age groups[35]. Therefore, it is paramount that the health clinics in this country are to be better supported including well supplied with more choices of pharmacological agents for the treatment of diabetes mellitus, hypertension and dyslipidaemia[36]. Fixed dose combination of these pharmacological agents had been shown to improve medication adherence and better disease control when compared to co-administered multiple therapy[37]. A more concerted efforts from both the policy makers and health care professionals at primary care level are needed to deliver a better complications screening strategy, personalized treatment regimen and patient self-management support programs[38-41].

Strength and Limitations

The strengths of this study include the population-based cohort design, the large sample size, the detailed data on diabetes-related complication and medication use. However, as with other studies based on administrative databases or registries, several limitations must be recognized. Participation of health facilities as source data providers to the registry database was on voluntary basis. They could represent those health facilities and physicians who were more interested in diabetes care and therefore not reflective of diabetes care delivered by Malaysian physician in general. The process measures of diabetes care at each health facility could also be affected by the vigilance in data entry. The more patients at each health facility that were enrolled into the ADCM and having their latest clinical parameters updated on timely basis would increase the accuracy of a study on the health facility's diabetes care. Therefore, this study reported the diabetes care at the four different public health facilities that were probably performing at their best effort in 2009. The proportion of unknown status for many complications was rather large, especially for retinopathy, nephropathy and IHD. However, this could well be reflecting the selective screening strategies employed within the resource constraint public health care facilities. With the cross-sectional design of this study which had the latest laboratory results updated for analyses, the effect of duration of medical care at each facility could not be factored in the regression model. With the decentralization policy of more stabilized patients from the public hospitals to public health clinics, this variable could be crucial in explaining the better performance of the health clinics' diabetes care, whether it was a "ripple effect" from the HS or the CS was actually delivering a better diabetes care is left uncertain at this point in time[8]. We recommend future analyses to be done on a more mature registry database to take this variable into consideration. Unobservable confounders, beside that were mentioned, may still exist and bias the results as evidenced by the modest effect of the models. Therefore, findings should be interpreted as associations instead of causations. Findings were based on a single integrated health system and may not

be generalizable to larger populations. This registry could be improved with inclusion of more potential risk factors and psychosocial outcomes such as quality of life measures.

CONCLUSIONS

In conclusion, public hospitals with specialist in Malaysia were treating older T2D patients with more diabetes-related complications and prescribing more medications. The patients treated at smaller hospitals without resident medical specialist had poor lipid control compared to the hospitals with specialist. Public health clinics with resident doctors/MO and family physicians/FMS were achieving lower glycaemia target and the recommended BP target compared to the hospitals with specialists. Effort is needed to improve the overall suboptimal diabetes care seen at the public health facilities in this country, with probably the highest return of health investment if targeted at the primary care level in view of the patients who were of younger age and with shorter duration of diabetes.grouping reagents.

ACKNOWLEDGEMENTS

This study received its funding from Ministry of Health, Malaysia. This study has been approved by the Medical Research Ethics Committee (MREC) on Dec 2008. Protocol Number from the National Medical Research Register: NMRR ID: 08-12-1167.

We would like to acknowledge the Director General of Health Malaysia for his support in the registry and his permission to publish this report. We are grateful to the following steering committee members of ADCM who had contributed tremendously to the success of the registry: Professor Wan Mohamed Wan Bebekar, Dr Zanariah Hussein, Dr G.R. Letchumanan a/k Ramanathan, Dr Rozita Zakariah, Professor Fatimah Harun, Dr Zaiton Ahmad, Dr Syed Alwi Syed Abd. Rahman, Dr Asmah Zainal Abidin, and Dr Nafiza Mat Nasir. We would like to thank Noor Akma Hassim and Tee Chin Kim who of Clinical Research Centre, Kuala Lumpur for all their statistic and logistic support. Special thanks also goes to Ms Lena Yeap from ClinResearch Sdn Bhd for her and team previous statistical support.

REFERENCES

1. Omar M, Tong SF, Saleh N, *et al.* A comparison of morbidity patterns in public and private primary care clinics in Malaysia. Malaysian Family Physician 2011; 6(1): 19-25.
2. Teng CL, Aljunid SM, Cheah M, Leong KC, Kwa SK. Morbidity and process of care in urban Malaysian general practice: the impact of payment system. Med J Malaysia 2003; 58(3): 365-74.
3. Ministry of Health, Malaysia. National Health Morbidity Survey III. Putrajaya; 2006.
4. Ministry of Health, Malaysia. National Health Morbidity Survey IV. Putrajaya; 2012.
5. Cherry DK, Hing E, Woodwell DA, Rechtsteiner EA. National Ambulatory Medical Care Survey: 2006 summary. Natl Health Stat Report 2008(3): 1-39.
6. Pierce M, Agarwal G, Ridout D. A survey of diabetes care in general practice in England and Wales. Br J Gen Pract 2000; 50(456): 542-5.
7. Wee SL, Tan CG, Ng HS, *et al.* Diabetes outcomes in specialist and general practitioner settings in Singapore: challenges of right-siting. Ann Acad Med Singapore 2008; 37(11): 929-35.
8. Ismail H, Wright J, Rhodes P, Scally A. Quality of care in diabetic patients attending routine primary care clinics compared with those attending GP specialist clinics. Diabet Med 2006; 23(8): 851-6.
9. Toh MP, Heng BH, Sum CF, Jong M, Chionh SB, Cheah JT. Measuring the quality of care of diabetic patients at the specialist outpatient clinics in public hospitals in Singapore. Ann Acad Med Singapore 2007; 36(12): 980-6.
10. Greenfield S, Rogers W, Mangotich M, Carney MF, Tarlov AR. Outcomes of patients with hypertension and non-insulin dependent diabetes mellitus treated by different systems and specialties. Results from the medical outcomes study. JAMA 1995; 274(18): 1436-44.
11. De Berardis G, Pellegrini F, Franciosi M, *et al.* Quality of care and outcomes in type 2 diabetic patients: a comparison between general practice and diabetes clinics. Diabetes Care 2004; 27(2): 398-406.
12. Greenfield S, Kaplan SH, Kahn R, Ninomiya J, Griffith JL. Profiling care provided by different groups of physicians: effects of patient case-mix (bias) and physician-level clustering on quality assessment results. Ann Intern Med 2002; 136(2): 111-21.
13. Mastura I, Chew BH, Lee PY, *et al.* Control and Treatment Profiles of 70,889 Adult Type 2 Diabetes Mellitus Patients in Malaysia. International Journal of Collaborative Research on Internal Medicine & Public Health 2011; 3(1): 98-113.
14. Awin N. A Review of Primary Health Care in Malaysia- A Report for the World Health Organization Western Pacific Region. Ministry of Health, Malaysia, 2001.
15. Chew BH, Mastura I, Shariff-Ghazali S, *et al.* Determinants of uncontrolled hypertension in adult type 2 diabetes mellitus: an analysis of the Malaysian diabetes registry 2009. Cardiovasc Diabetol 2012; 11(1): 54.
16. WHO Consultation. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus. Geneva: World Health Organisation; 1999. Report no. 99.2.
17. Ministry of Health, Malaysia. Management of Type 2 Diabetes Mellitus. putrajaya: Technology, Health Section, Assessment Division, Medical Development; 2009.
18. Standards of Medical Care in Diabetes—2012. Diabetes Care 2012; 35(Supplement 1): S11-S63.
19. Ministry of Health, Malaysia. Health Technology Assessment Unit. Clinical Practice Guidelines- Management of Hypertension. Expert review of cardiovascular therapy. Putrajaya; 2008.
20. Chew BH, Ismail M, Lee PY, *et al.* Determinants of uncontrolled dyslipidaemia among adult type 2 diabetes in Malaysia: The Malaysian Diabetes Registry 2009. Diabetes Res Clin Pract 2012; 96: 339-47.
21. Lee PY, Cheong AT, Zaiton A, *et al.* Does Ethnicity Contribute to the Control of Cardiovascular Risk Factors Among Patients With Type 2 Diabetes? Asia Pac J Public Health 2011.[In Press]
22. Y H Chan. Biostatistics 202: Logistic regression analysis. Singapore Med J 2004; 45(4): 149-153.
23. Tai TY, Chuang LM, Tsai ST, Huang BY, Diabcare Study G. Treatment of type 2 diabetes mellitus in a primary care setting in Taiwan: comparison with secondary/tertiary care. J Formos Med Assoc 2006; 105(2): 105-17.
24. Arai K, Hirao K, Matsuba I, *et al.* The status of glycemic control by general practitioners and specialists for diabetes in Japan: a cross-sectional survey of 15,652 patients with diabetes mellitus. Diabetes Res Clin Pract 2009; 83(3): 397-401.
25. Jaakko T. Impact of age on cardiovascular risk: implications for cardiovascular disease management. Atheroscler Suppl 2004; 5(2): 9-17.
26. Hubert K, Berthold S, Lutz H, *et al.* Type 2 diabetes phenotype and progression is significantly different if diagnosed before versus after 65 years of age. J Diabetes Sci Technol 2008; 2(1): 82-90.
27. George D. Early and Intensive Therapy for Management of Hyperglycemia and Cardiovascular Risk Factors in Patients With Type 2 Diabetes. Clin Ther 2011; 33(6): 665-78.
28. Soe K, Sacerdote A, Karam J, Bahtiyar G. Management of type 2 diabetes mellitus in the elderly. Maturitas 2011; 70(2): 151-9.
29. Bi Y, Zhu D, Cheng J, *et al.* The status of glycemic control: A cross-sectional study of outpatients with type 2 diabetes mellitus across primary, secondary, and tertiary hospitals in the Jiangsu province of China. Clin Ther 2010; 32(5): 973-83.
30. Peyrot M, Rubin RR, Lauritzen T, *et al.* Patient and provider perceptions of care for diabetes: results of the cross-national DAWN Study. Diabetologia 2006; 49(2): 279-88.
31. Parchman ML, Zeber JE, Palmer RF. Participatory Decision Making, Patient Activation, Medication Adherence, and Intermediate Clinical Outcomes in Type 2 Diabetes: A STARNet Study. Ann Fam Med 2010; 8(5): 410-7.
32. Skyler JS, Bergenstal R, Bonow RO, *et al.* Intensive glycemic control and the prevention of cardiovascular events: implications of the ACCORD, ADVANCE, and VA diabetes trials: a position statement of the American Diabetes Association and a scientific statement of the American College of Cardiology Foundation and the American Heart Association. Diabetes Care 2009; 32(1): 187-92.
33. Marshall SM. Intensive diabetes management for high-risk patients: how best to deliver? Diabetes Care 2009; 32: 1132-3.

34. Mónica O, Stephen L, Dan C, Shanthi M. Cost effectiveness of strategies to combat cardiovascular disease, diabetes, and tobacco use in sub-Saharan Africa and South East Asia: mathematical modelling study. BMJ 2012; 344.
35. CDC Diabetes Cost-effectiveness Group. Cost-effectiveness of Intensive Glycemic Control, Intensified Hypertension Control, and Serum Cholesterol Level Reduction for Type 2 Diabetes. JAMA 2002; 287(19): 2542-51.
36. Pawaskar M, Li Q, Reynolds MW. Metabolic outcomes of elderly patient populations initiating exenatide BID versus insulin glargine in an ambulatory care setting. Curr Med Res Opin 2012; 28: 991-7.
37. Han S, Iglay K, Davies MJ, Zhang Q, Radican L. Glycemic effectiveness and medication adherence with fixed-dose combination or coadministered dual therapy of antihyperglycemic regimens: a meta-analysis. Curr Med Res Opin 2012; 28: 969-77.
38. Brownson CA, Hoerger TJ, Fisher EB, Kilpatrick KE. Cost-effectiveness of Diabetes Self-management Programs in Community Primary Care Settings. Diabetes Educ 2009; 35(5): 761-9.
39. White RD. Patient empowerment and optimal glycemic control. Curr Med Res Opin 2012; 28: 979-89.
40. Khunti K, Gray LJ, Skinner T, *et al.* Effectiveness of a diabetes education and self management programme (DESMOND) for people with newly diagnosed type 2 diabetes mellitus: three year follow-up of a cluster randomised controlled trial in primary care. BMJ 2012; 344: e2333.
41. Wolf AM, Siadaty M, Yaeger B, *et al.* Effects of lifestyle intervention on health care costs: Improving Control with Activity and Nutrition (ICAN). J Am Diet Assoc 2007; 107(8): 1365-73.