ORIGINAL ARTICLE

Descriptive Analysis of Type 2 Diabetes Mellitus Patients Using Data From Hospital Information System

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ABSTRACT

Introduction: Electronic medical records from hospital information system (HIS) offer a major potential for secondary data analysis which can improve the efficiency of healthcare delivery. This study describes an initiative to use HIS data to explore the level of diabetic care in patients with T2DM in a hospital-based outpatient clinic, the advantages and challenges in utilising HIS data. **Methods:** Patients age of 18 and above who received any diabetes medication in 2013 were retrospectively identified from HIS of Serdang Hospital. Demographic characteristics, anti-diabetic agent (ADA) dispensed, and glycaemic measures were quantified. Data was extracted using structured query language (SQL) and descriptive statistical analyses were conducted using Stata Version 12. **Results:** Prevalence of T2DM patients in the hospital was 7.5%. Male had slightly higher prevalence and patient at age of 61-70 years old. About 62% of patients were prescribed with metformin and 5% of newer combination of oral hypoglycemic agent. In prescribing pattern, stratification by age group, showed that patient age 41 to 70 years received mostly monotherapy, whilst 61.1% continue their regime for the year. Only 18% obtained good glycaemic control. **Conclusion:** Hospital Information system is a critical instrument in providing data as a platform in diabetic care in an outpatient care. Moving forward, steps to improve HIS should be taken to seize its potential as a tool to increase the efficiency of healthcare delivery.

Keywords: Hospital Information Systems, Medical Records, Diabetes Mellitus, Type 2, Outpatient Clinic, Malaysia

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INTRODUCTION

Uses of Information technology (IT) will likely impact the healthcare system by improving efficiency of service delivery. Public hospitals are adopting IT tools such as Electronic Medical Records (EMR) and integrate them in the Hospital Information System (HIS)(1–4) . This networking allows data from different locations to be accessed with high level of security in place(5). Hospital Information System (HIS) in Malaysia started at Selayang and Putrajaya Hospital as well as Putrajaya Clinic has been successfully being implemented since 1998 (4). HIS defined as an integrated electronic systems that collect, store, retrieve, analyse and display overall patients' data and information which are used in several departments within hospitals (6). The three categories of HIS are Total Hospital Information System (THIS), Intermediate Hospital Information System (IHIS), and Basic Hospital Information System (BHIS). Today, 21 out of 138 hospitals are implementing either one of these systems (7). Implementation of different Information System (IS) will determine different classification of HIS. THIS using a complete HIS components often referred as paperless hospitals while IHIS and BHIS stand as hybrid system maintaining both manual and electronic records (2).

There are at least twelve IS to support efficient patient care management in hospital with THIS in a local Malaysia setting. When a patient visited an Outpatient Department (OPD), all activities were captured into six different IS. Firstly, registration occurs at the registration counter to get the purpose and payment for the visit. These activities captured in patient registration table under Patient Management System (PMS) and Billing Management System as depicted in Fig. 1. Secondly, the patient will be consulted at specific specialty and all the consultation data were captured in document management under Clinician Access (CA). If the patient needs to go for certain procedure like laboratory or radiology, the data will be captured under Laboratory or Radiology Information Systems. Thirdly, when patient went for medication filled at pharmacy department, all

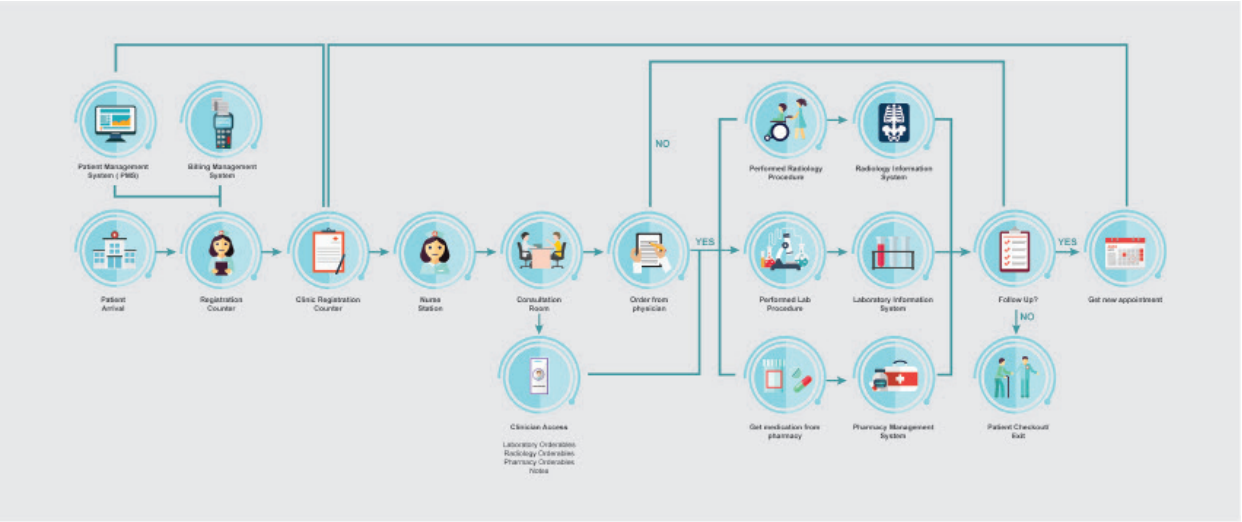

Figure 1: Entity Relationship Diagram for Hospital Serdang

the data regarding the medication were captured under Pharmacy Information System (PIS). Lastly, for the next OPD follow-up, the new appointment will be captured under PMS.

HIS has enable to record patient's demographics, histories, details of visit, previous prescription as well as active medication lists. These functions have significant implications for the patient's management especially of chronic and non-communicable diseases like T2DM. Among others, activities that contribute to the meaningful use of EMR in diabetes care are recording diabetes status and complications, implementing electronic reminders, generating forms for patient follow-up care, implementing indicators for clinical-practice improvement, reporting clinical quality measures, providing information for professional communication, generating list of patients to include in medical intervention, education or research and exporting data to diabetes registers (8).

Several other uses of secondary data from HIS that can aid in improving diabetes management including assessment of diabetes prevalence (9), drug utilization and treatment pattern (10,11), utilization of healthcare resources(12) and cost of diabetes care(13,14). All the evidence generated from secondary data is essential for improving and further shaping health policies and guidance on effective use of medical resources. Furthermore, the HIS data can be crucial source for population health and disease research when linked with mortality and genetic data (15). Accurate, complete and reliable HIS data can be made available for various research area and subsequently used to improve global burden of disease.

Currently, in Malaysia study on HIS is mainly focuses on the adoption of HIS and until this paper was written, there is lack of published evidence linking the use of electronic medical records (EMR) to HIS for management of T2DM, therefore this paper describes a collaborative research project that uses EMR to explore the level of diabetic care in hospital OPD. The aim of this study is to carry out a descriptive analysis of T2DM patients using HIS data and to identify the challenges and advantages from HIS data utilisation.

MATERIALS AND METHODS

An automated hospital-based database obtained from THIS developed by iSOFT Group Limited (ASX: ISF) was utilised. The database contained administrative and clinical data for all the patients visited outpatient department (OPD) in 2013 from Serdang Hospital. Due to the absence of diagnosis code (ICD-9 and (ICD-10) for out-patient services, the identification of T2DM was done via diabetes medication dispensed. Since the activities in OPD were captured by different modules/ tables in the THIS, there were four datasets extracted for analysis of this study namely OPD, drug dispensed, pharmacy and laboratory. Data was extracted using structured query language (SQL) and descriptive statistical analyses were performed using Stata Software v12. Required data retrieved were then clean, collated and compiled into a new database to enable analysis. Data were also assessed for completeness, consistency and accuracy.

Pharmacy dataset were used in identification of diabetic drugs while patient received diabetic drugs was identified and obtained from PIS. Based on hospital list of diabetic drugs available (32 items), patient identification (ID) received any drug from the list was extracted from PIS. With the diabetic patient ID identified, the ID then merged into OPD dataset. This dataset contains information about patient's medical journey during each visit in the OPD. PMS provides demographic variables and Clinician Access showed what was ordered to the patients during their OPD visit. This helps to determine the prevalence of T2DM and the profiling of T2DM patients in the hospital. Patients age 18 and below were excluded from the analysis. Missing data or unknown classifications of data were

dropped from the analysis. Gestational diabetes patient, polycystic patient and Type 1 Diabetes Mellitus patient were also excluded from the study.

Analysis for drug utilisation is done using information in PIS as it captured both prescribed drugs during consultation with physician and drugs refill at pharmacy department before the new appointment. Item or medication ordered during patients visits served as a proxy for resource utilization among T2DM patients. Current practice for T2DM patients, the appointment was given at intervals ranging from three to six months.

Based on PIS, we have nine classes of diabetic drugs name assigned with Anatomical Therapeutic Chemical (ATC) classification A10. There were a total of 107 possible combination of diabetic drug treatment throughout the year for each patient to classify into six treatment types whether it is monotherapy, dual oral hypoglycaemic agent (OHA), three OHA, four OHA, insulin plus OHA or insulin alone. Any changes in OHA throughout calendar year 2013 were then identified as modified treatment pattern.

Data on laboratory test such as HbA1c, 2-hours post prandial glucose (2HPP), fasting blood sugar (FBS) and random blood sugar (RBS) were extracted from LIS. The date and sequence of the tests also been identified. The tests were coded accordingly and a new variable indicating sequence of tests done was generated. This paper only describes the analysis conducted for HbA1c since it gives a measure of control in three months span for T2DM.

RESULTS

From this study, the prevalence of T2DM in OPD in Hospital Serdang is 7.5%. The T2DM patients generally are slightly older than all OPD patients with an increasing age trend, peaking at 61-70 years old. Male had higher prevalence of T2DM. In HIS data, ethnicity originally has 18 options and was recorded into five main categories and non-citizen. Indian ethnicity showed highest prevalence followed by Chinese ethnicity and Malay as shown in Table I.

Metformin was prescribed for majority of the patients (61.8%), followed by sulphonylurea derivatives group (46.3%) and intermediate-acting insulin (39.4%). Insulin (fast, long and intermediate acting) was used by 3,227 individuals, corresponding to 61.6% of all patients with type 2 diabetes. Lower usage of new generation of ADA were also observed among T2DM where the usage is less than 5% (Table II).

Common oral hypohlycaemic agent (OHA) pattern observed were monotherapy (29.6%), followed by dual OHAa (24.4%) and combination of OHA plus insulin (23.3%) as in Table III. These patterns were observed

Table I: Demographic description of all patients visiting OPD with diabetes prevalence

		All patients	T2DM	
		N	n	%
Total patients		101,371	7604	7.5
Age (mean±sd)		55.9±14.1	57.9±12.3	
Age group	18-20	5,145	20	0.4
	21-30	30,450	263	0.9
	31-40	21,367	592	2.8
	41-50	12,681	1,133	8.9
	51-60	13,862	2,362	17
	61-70	10,991	2,142	19.5
	>70	6,875	1,092	15.9
Gender	Males	49,178	4,338	8.8
	Females	52,193	3,266	6.3
Ethnicity	Malay	59,906	3,880	6.5
	Chinese	15,836	1,756	11.1
	Indian	14,222	1,836	12.9
	Non-Citizen	8,663	55	0.6
	Others	1,798	61	3.4
	Other Bumiputra	946	16	1.7

Table II: Frequency of Antidiabetic agents (ADA) received by T2DM patients

Antidiabetic Agent	Use n	Percent %
Biguanides (Metformin)	3,234	61.8
Sulfonylurea (glibenclamide, gliclazide)	2,423	46.3
Insulin injection (intermediate acting)	2,065	39.4
Insulin injection (fast acting)	1,078	20.6
Alpha-glucosidase inhibitor (Acarbose)	318	6.1
Combination oral ADA (Metformin+Glibenclamide)	138	2.6
DPP4-inhibitors (Sitagliptin, Saxagliptin)	85	1.6
Insulin injection (long acting)	84	1.6
Combination oral ADA (Saxagliptin + Metformin)	63	1.2
Thiazolidinedione (Rosiglitazone)	6	0.1

Table III: Pattern of drug utilization, by age group

Therapy	Age group							Total (n)	Per-cent (%)
	18-20	21-30	31-40	41-50	51-60	61-70	>70		
Mono-therapy	5	55	109	193	440	448	298	1,548	29.6%
2oha*	1	9	56	183	435	408	185	1,277	24.4%
3oha	0	3	8	33	60	50	9	163	3.1%
4oha	0	0	0	3	6	3	0	12	0.2%
Insulin & oha	1	23	68	218	429	348	133	1,220	23.3%
Insulin	11	44	94	107	259	299	144	958	18.3%
non_ dm**	0	2	6	8	18	18	7	59	1.1%
Total	18	136	341	745	1,647	1,574	776	5,237	100%

*oral hypoglycaemic agent **non-diabetic mellitus

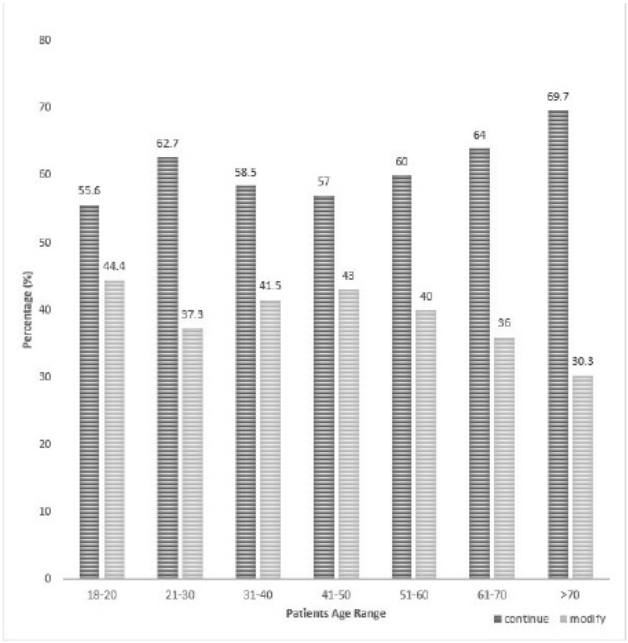

Figure 2: Treatment modification among T2DM patients, stratified by age

among patient aged 41 to 70 years old. Metformin was the most used drugs as single agent, in combination with other oral and also with insulin. Intermediate acting insulin (pre-mix or combination of fast and intermediate) used most in T2DM management.

Overall, in this hospital, 61.1% of T2DM patients continued their medication regime for a year. As shown in Fig. II, the proportion of treatment modification also appears slightly reduced with increasing age. Further analysis showed that among the T2DM patients, 80% (4,232) of the patients had HbA1c test done at least once in 2013. Good glycaemic control of <6.5% as defined by Malaysian CPG in 2009 was achieved by 18% (mean 8.3% ±2.0.) of patients . However, if assessed against the international standard of HbA1c (less than 7%), the percentage increased to 30.7%.

DISCUSSION

In Malaysia, data from the National Health and Morbidity Survey (NHMS) reported in 2015 that a total of 3.5 million Malaysian, or 7.2% of the population, had diabetes (16). However, higher prevalence of diabetes was observed in current health facility compared to community as reported from the NHMS 2015 (7.5% vs 7.2%). Nonetheless, limited local data on the prevalence of diabetes in outpatient setting that allow comparison with current study. A national survey of 44 United States hospitals estimated that diabetes and hyperglycaemia occurred in 5–30% of all types of patients admitted to the hospital (17) and another observational study also in the US reported a prevalence of hyperglycaemia and diabetes ranging from 38% to 40% in the hospitals (17). In this study, the highest number of diabetic patients in Malaysia outpatient setting was in the age range of 60 and above at 44%. Similar observations was also reflected by an outpatient study in India, whereby patient at the age 60-69 years had highest diabetes patients at 52.7% (18).

Metformin was prescribed for the majority of patients followed by sulphonylurea, urea derivatives and intermediate-acting insulin. Metformin has been used as the first line of treatment in management of T2DM. This study found that glibenclamide and glicazide are the most commonly prescribed sulphonylurea, and they have been proven to decrease the risk of macrovascular outcomes among adult with T2DM (19). Demographic and utilization pattern were usually discussed together as stratification of anti-diabetic medication by age showed that monotherapy was dominant across all age groups: mostly used by patient age 61-70. Dual oral hypoglycemic agent followed and finally combination of insulin and oral hypoglycemic agent dominant at the age of 51-60 years. There were 12 patients (0.2%) prescribed up to 4 oral hypoglycemic agent. The incidence of polypharmacy has been linked with poor glycaemic control. Study on drug prescribing pattern is critical in helping to monitor, evaluates prescribing practices and make necessary recommendations to modify or continue the same regime in order to improve patient outcome.

As the study collected data for 2013, 61.1% of T2DM patients continued their medication regime for a year whilst the rest of patients had their medication modified. In diabetic patient management, the primary objective is to achieve glycaemic control and prevent complications associated with uncontrolled blood glucose level. With 2013 data, only 18% achieved good glycaemia control with no treatment modification done.

In this study, EMR data was used and analysed to observed oral hypoglycaemic agent pattern utilization. The integration of EMR into diabetes care has seen improvement in terms of compliance and blood glucose control (20). However, currently in Malaysia, EMR was mainly for enhancing patient experience and increase patient management efficiency. Number of studies has been conducted to explore adoptability, user satisfaction as well as implementation of HIS in Malaysia (3,6,21). This study adds value, by exploring the usage of HIS in anti-diabetic utilisation pattern. International study used EMR to investigate patient outcome and found improved outcome for diabetes mellitus on their sites (22). Another study conducted in United States aim to see the role and importance of EMR in improving health care and subsequently lead to maximize their benefits and usage (23) . This study focuses on health information technology usage in chronic disease management.

Most study identified T2DM using International Classification of Disease, Tenth Revision (ICD-10) codes E111-E119, E140-E149, and E14X or ICD-9 codes

of 250.b This facilitates easier patient identification. However, in this study identification of T2DM patients was from diabetic medication list since outpatient department did not utilise ICD10 or ICD9. As selection of adult patient was based on a cut-off age of 18 and above, there was a probability of including adult T1DM patient in the study population. Thirdly, unstructured data especially in pharmacy of EMR database has become a setback in this study. Data management had taken most of the time and was on a few rounds to ensure data quality. Standardisation of data captured into HIS should be made as this will allow secondary data utilization for analysis.

CONCLUSIONS

This study has been able to show that EMR is able to provide information on the prevalence of T2DM (7.5%) in OPD setting, with 61.1% T2DM patients continued their treatment and only 18% achieved glycaemic target in patient management. Moving forward, steps to improve HIS should be taken to seize its potential as a tool to increase the efficiency of healthcare delivery.

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