

The Singapore National Healthcare Group Diabetes Registry – Descriptive Epidemiology of Type 2 Diabetes Mellitus

Bee Hoon Heng,¹ MBBS, MSc (Public Health), FAMS, Yan Sun,¹ MSc (Data Mining), PhD (Med Info), Jason TS Cheah,² MBBS, MMed (Public Health), FAMS, Michelle Jong,³ MBBS, FRCP (UK), FAMS

Abstract

Introduction: The National Healthcare Group (NHG) launched an enterprise-wide diabetes registry in 2007. We describe the epidemiology of type 2 diabetes mellitus from 2005 to 2008. **Materials and Methods:** Patients with encounters in NHG from 2005 were identified for inclusion into the Diabetes Registry from existing stand-alone diabetes registries, ICD9CM diagnosis codes, anti-hyperglycaemic medication and laboratory confirmation. Variables extracted for analysis were demographics (age, gender, ethnicity), diabetes-related comorbidities and complications, most recent anti-hyperglycaemic agents dispensed, and the most recent glycated haemoglobin (HbA1C) measurement. **Results:** The diabetes registry grew 32% from 129,183 patients in 2005 to 170,513 patients in 2008, making up 12% to 15% of all patients in NHG. About half of the type 2 diabetes patients were aged 45 to 64 years. Females were generally older with a median age of 63 to 64 years vs 59 to 61 years in males. The Indian ethnic group accounted a disproportionately higher 13% of patients. Over 95% of type 2 patients had at least one diabetes-related comorbid condition, and diabetes-related complications were principally renal and cardiovascular complications. The majority (86.2% to 89.2%) of primary care patients were on oral anti-hyperglycaemic agents; however, the rate of insulin treatment increased from 10.8% to 13.8%. HbA1C levels in 2008 improved over that in 2005, with the percentage of patients with good glycaemic control improving with age. **Conclusion:** The registry has enabled a baseline assessment of the burden and the care of type 2 diabetes patients in NHG, which will provide critical “evidence” for planning future programmes.

Ann Acad Med Singapore 2010;39:348-52

Key words: Comorbidities, Complications, Planning

Introduction

Diabetes mellitus is one of the most challenging global health problems in the 21st century. It is associated with excess mortality¹ and significant morbidity from complications, which lead to disability, poor quality of life and an enormous health cost. In Singapore, diabetes mellitus affects 8.2% of the population aged 18 to 69 years,² and is the seventh most common cause of death,³ although the extent of mortality from diabetes-related complications could be significantly higher.¹ These are compelling reasons to ensure that diabetes patients are adequately managed.

Quality care of diabetes patients requires a population-based, evidence-based and patient-centric approach. Evidence-based clinical practice guidelines⁴ aim to prevent complications, improve quality of life, and reduce disability

and mortality. Care spans horizontally across a continuum of patients' lives, and requires a multidisciplinary team across primary, secondary and tertiary levels of care. Care should be holistic, seamless and integrated across institutions and at different levels of care, and will suffer if it is acute, reactive and fragmentary.

In 2008, it is estimated that there are 328,000 persons with diabetes in Singapore. About a third of them are under the regular care of various institutions within the National Healthcare Group (NHG), one of 2 public healthcare clusters of integrated network of healthcare facilities spanning across 3 acute hospitals, 9 primary care polyclinics, and national specialty centres serving 2.2 million population. In the NHG, the burden of diabetes, standard of care, and baseline are largely unknown; and evaluation and audits of

¹ Health Services & Outcomes Research, National Healthcare Group, Singapore

² Formerly from National Healthcare Group Polyclinics

³ Department of Endocrinology, Tan Tock Seng Hospital

Address for Correspondence: Dr Heng Bee Hoon, Health Services & Outcomes Research, National Healthcare Group, 6 Commonwealth Lane, #04-01/02 GMTI Building, Singapore 149547.

Email: bee_hoon_heng@nhg.com.sg

care have been carried out manually on small⁵ or convenience samples.⁶ The NHG needed a fundamental systems and information strategy. Information technology and registries provide a powerful solution and are critical components to high quality chronic illness management.⁷

From 2006, the NHG began its development of an enterprise-wide chronic disease management system (CDMS). The system sought to link key administrative and clinical information to provide seamless care for our patients with chronic diseases, that is, diabetes mellitus, hypertension, dyslipidaemia, stroke, cardiovascular diseases and chronic renal disease. The first chronic disease registry developed was for diabetes mellitus.

Commissioned in July 2007, the diabetes registry aims to (i) give care providers updated and timely clinical outcomes of each patient, trend over time, and alert them on the schedule of tests at specified intervals in accordance to clinical practice guidelines; (ii) improve quality of care through system-wide outcomes surveillance, audits and feedback mechanisms; (iii) provide summary reports to patients; (iv) segment patients for targeted programmes and interventions; and (v) enable epidemiological and longitudinal studies, and health services research in support of planning, policies and evaluation of programmes. It has the critical components and capabilities of a chronic disease registry^{8,9} for individual and population management, and will allow the NHG to identify and manage its diabetes patients proactively, consistently and effectively to delay the development of costly and debilitating diabetes-related complications; and seamlessly integrating care horizontally and vertically.

Details of the development of the diabetes registry to improve quality of care in NHG have been previously documented.¹⁰ There is currently a void in information on the total burden of type 2 diabetes in NHG institutions. This paper describes workload of type 2 diabetes, prevalence of diabetes-related comorbidities and complications, drug treatment and glycaemic control for the period 2005 to 2008. It serves as a useful baseline for future evaluation.

Materials and Methods

Diabetes patients with encounters in NHG from 2005 were identified using a passive surveillance system applied to various computer systems (administrative, financial, laboratory, pharmacy) across all disciplines and spanning across all NHG institutions. Identified cases of selected chronic diseases were drawn into a layer above the data source, the operations data store (ODS). Diabetes patients were then drawn from the ODS to populate the diabetes registry. The ODS serves as a springboard layer for mandatory reporting of various indicators to the Ministry of Health, and for building future similar registries. Data

from multiple visits and multiple sources were linked to specific patients through the Singapore National Registration Identification unique number. Data were extracted at the end of each day and shared across all NHG institutions the following day.

To ensure comprehensive capture of all diabetes patients into the registry, the following rules, ranked in descending order, were used: (i) Rule 1, patients from existing stand-alone diabetes registries; (ii) Rule 2, patients with diagnosis code of §250 (§250.0-§250.9) under the International Classification of Diseases, 9th Revision, Clinical Modification (ICD9CM), coded as either the primary or secondary diagnosis; (iii) Rule 3, patients on anti-diabetes medication; and (iv) Rule 4, patients with 2-hour blood sugar level of ≥ 11.1 mmol/L on oral glucose tolerance test (OGTT), or a random blood sugar level of ≥ 11.1 mmol/L on 2 occasions within 2 years, or fasting plasma glucose ≥ 7.0 on 2 occasions within 2 years, or random blood sugar level of ≥ 11.1 mmol/L and fasting plasma glucose ≥ 7.0 within 2 years. Patients within the NHG institutions who underwent opportunistic health screening and qualify random blood glucose criteria were also included. However, these patients were often confirmed by an OGTT.

Variables extracted from the diabetes registry for the study included demographics (age, gender and ethnic group), diabetes-related comorbidities and complications, most recent anti-hyperglycaemic agents dispensed, and glycaemic control using the most recent glycated haemoglobin (HbA1C) measurement. Ethnic group was taken as that declared by the patient and recorded in the administrative system. The Singapore population is classified into 4 ethnic categories, that is, Chinese, referring to persons of Chinese origin; Malays, referring to persons of Malay or Indonesian origin; Indians, referring to persons of Indian, Pakistani, Bangladeshi and Sri Lankan origin, and Other ethnic group, comprising all other persons other than Chinese, Malays and Indians, and include Eurasians, Caucasians, Arabs and Japanese.¹¹ Comorbidities associated with diabetes included hypertension and dyslipidaemia. Diabetes-related complications were classified as: (i) eye, which included non-proliferative and proliferative retinopathy, macular oedema, cataract and glaucoma; (ii) cardiovascular, which included ischaemic heart disease and acute myocardial infarction; (iii) cerebrovascular, which included cerebrovascular accidents and transient ischaemic attacks; (iv) nephropathy, which included microalbuminuria, overt proteinuria, chronic renal failure (with or without nephritic syndrome) and end-stage renal failure; and (v) limb, which included dermopathy, peripheral vascular disease and neuropathy. These complications were derived from ICD9CM codes.

Type 2 diabetes patients could either be hospitalised or

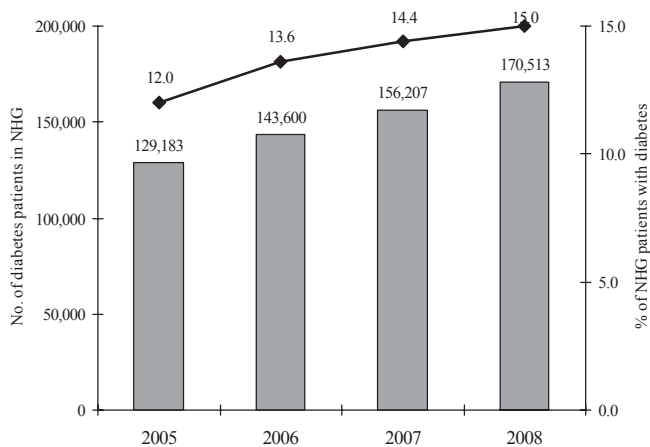


Fig. 1. Total number of diabetes (type 1 and type 2) patients in NHG, 2005-2008.

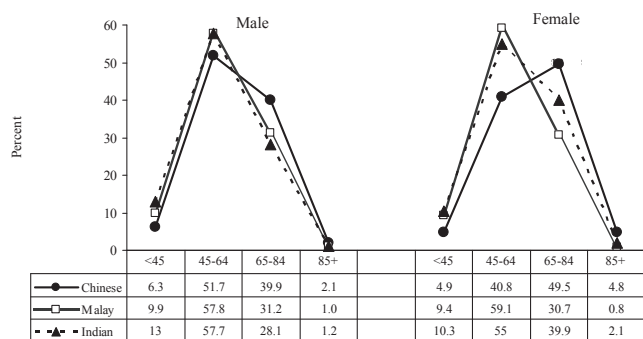


Fig. 2. Ethnic, gender and age distribution of type 2 diabetes patients, 2008.

seek treatment in an ambulatory clinic. They may choose to be treated in an ambulatory clinic in NHG institutions or elsewhere (the other healthcare cluster or private clinics).

This paper focused on regular care of diabetes patients in the NHG ambulatory clinics, which comprise NHG primary care clinics (PCCs) and hospital-based specialist outpatient clinics (SOCs). The quality of care was attributed to the particular clinic if patients were regularly managed at these “base” clinics. “Base” clinics were those where patients had at least 2 attendances within 6 months, and where anti-diabetes medication was prescribed and/or HbA1C tests carried out and/or assigned a IDC9CM diagnosis code of §250. HbA1C levels of <7% was considered good control.¹² Data were analysed using Statistical Package for the Social Sciences (SPSS), version 15 program. The study was approved by the NHG’s Domain-specific Ethics Board C.

Results

Total Disease Burden

The size of the registry grew 32% from 129,183 patients in 2005 to 170,513 patients in 2008, and the corresponding rate of diabetes among all patients in the NHG increased from 12% to 15% (Fig. 1). About half of the diabetes patients

Table 1. Prevalence of Diabetes-related Comorbidities and Complications, 2005-2008

	Prevalence rate (%)							
	Primary Care Clinics				Specialist Outpatient Clinics			
	2005	2006	2007	2008	2005	2006	2007	2008
Comorbidities*:								
Diabetes only	7.4	4.7	3.2	1.5	14.5	10.0	6.5	4.1
Diabetes and hypertension	13.0	8.1	5.1	2.2	10.6	7.4	4.5	2.2
Diabetes and dyslipidaemia	15.8	17.4	17.4	18.6	21.2	22.5	22.7	24.4
Diabetes, hypertension and dyslipidaemia	63.9	69.8	73.6	77.7	53.6	60.1	66.2	69.2
Complications†:								
Renal	13.0	15.9	18.8	22.6	28.0	31.7	33.2	34.9
Cardiovascular	16.5	16.9	17.1	17.8	20.2	23.6	26.1	32.7
Cerebrovascular	8.5	9.7	10.6	10.3	11.3	12.0	12.6	14.5
Eye	4.0	5.6	7.0	8.0	16.8	18.9	19.4	19.5
Limb (dermatopathy, peripheral vascular disease, neuropathy)	3.0	3.7	4.6	5.3	13.2	15.6	19.8	23.8

* with or without diabetes-related complications

† each patient may have one or more diabetes-related complications

were regularly managed in base PCCs and SOCs; of these, about 80% were by PCCs.

Demographic Characteristics

Among type 2 diabetes patients, there was a slightly higher percentage of females (51.1% to 52.9%). Overall, about half (46.6% to 50.2%) of all patients were aged 45 to 64 years. Females were generally older with a median age of 63 to 64 years vs 59 to 61 years in males. Ethnic distribution showed a relatively higher proportion of Indians (about 13%); Indians made up 9% of the Singapore population in 2008).¹³ Figure 2 shows that in 2008, Malays and Indians had higher rates of type 2 diabetes among those aged <65 years, while the Chinese had higher rates among those aged 65 years and above; the ethnic and age disparity being more pronounced among the females.

Diabetes-related Comorbidities and Complications

Table 1 shows that in 2008, over 95% of type 2 patients had at least 1 diabetes-related comorbid condition. The rate of patients with both hypertension and dyslipidaemia increased from 63.9% to 77.7% in PPCs and 53.6% to 69.2% in SOCs from 2005 to 2008. Similarly, the prevalence of diabetes-related complications showed an increasing trend, led principally by renal and cardiovascular complications. As

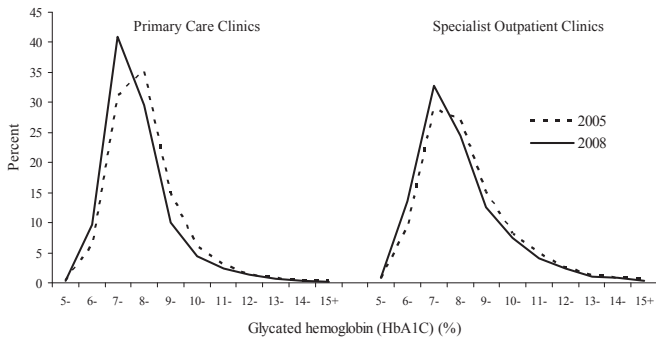


Fig. 3. Distribution of HbA1C among type 2 diabetes patients, 2005, 2008.

expected, the prevalence of diabetes-related complications was higher in SOC than in PPC.

Treatment with Anti-hyperglycaemic Agents

Among the type 2 diabetes patients on pharmacotherapy, majority (86.2% to 89.2%) of PCC patients and 68.7% to 71.1% of SOC patients were on oral anti-hyperglycaemic agents. The rate of insulin treatment in both PPCs and SOC has been progressively increasing over time, majority of whom were on combination insulin and oral anti-hyperglycaemic agents. In 2008, 13.8% of type 2 diabetes patients in PCCs and 31.3% of patients in SOC were on insulin.

Glycaemic Control

Figure 3 shows the distribution of HbA1C, with levels in 2008 improving over that in 2005; i.e. a shift of the curve to the left. There was generally no significant gender disparity in glycaemic control. However, the percentage of patients with good glycaemic control improved with age, and among the 3 major ethnic groups, more Chinese and Malays achieved the glycaemic target of <7% (Fig. 4) compared to Indians.

Discussion

A central feature of a registry is the continuous feedback to the organisation and the healthcare providers to improve the quality of care of our patients. This registry is a “census” of every diabetes patient in the NHG that enables detailed epidemiological assessment and quantifies the burden of diabetes to NHG. The usefulness of the registry goes beyond its original goal of data integration, decision support, audit, data access at the point of care, to provide critical “evidence” for planning at the national and cluster levels. To the best of our knowledge, this is the first cluster-wide attempt at stock-taking diabetes in Singapore.

The proportion of patients in NHG with diabetes has increased from 12% in 2005 to 15% in 2008. The increase could in part be contributed by the various screening

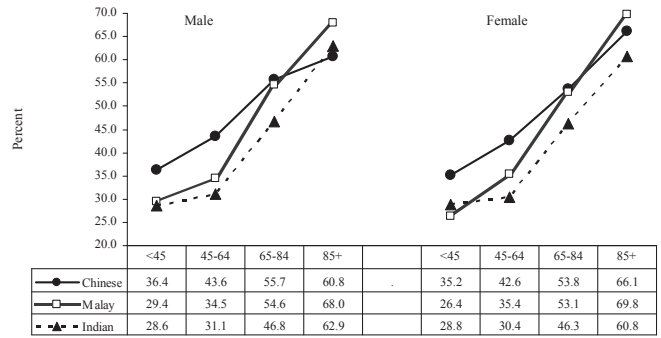


Fig. 4. Proportion of type 2 diabetes patients with good glycaemic control (HbA1C<7%), 2008.

programmes by the government and other health agencies resulting in the detection of newly diagnosed cases, minus attrition from mortality. However, the lack of auto-population of national death information into the registry has been a significant limitation due to non-access to the national information on death. Nevertheless, the rate of increase is set to continue with the increasing prevalence of obesity amongst Singaporeans² and the rapidly ageing population.¹² Others have projected future prevalence of diabetes¹⁴ and the consequences of the alarming rate of increase will overwhelm healthcare systems and need urgent efforts to curb the epidemic. With the highest proportion of patients belonging to the younger age group of 45 to 64 years, similar to that seen in developing countries in Asia,¹⁵ this is a concern as it will result in major economic burden due to premature ill health and death. The Singapore Ministry of Health has taken steps to address the growing public health problem through its Chronic Disease Management Programme which started in October 2006. It has engaged the support of general practitioners to provide systematic, evidence-based chronic disease management programmes (including diabetes mellitus), and allowed the use of Medisave (a portion of contribution towards the central provident fund, a compulsory savings scheme in Singapore) to reduce the out-of-pocket cash payments for outpatient bills.¹⁶

The higher prevalence of comorbidities and complications among SOC patients is expected as the more severe patients get referred for management. It is heartening that despite the increasing prevalence of diabetes-related comorbidities and complications, glycaemic control over the 4 years has improved. However, these diagnosed patients represent the tip of the iceberg as in Singapore, about 50% of all persons with diabetes are unknown and undiagnosed.² As persons with type 2 diabetes will progress to nephropathy, and tight glycaemic control is critical in slowing progression of diabetic nephropathy,^{17,18} and long duration of untreated unknown disease may explain high prevalence of diabetic

kidney disease¹⁹ present in 1 in 4 PCC and 1 in 3 SOC patients in 2008. Results of a European type 2 diabetes cohort reported a decline in glycaemic control over time and attributed it to the progressive nature of the disease.²⁰ In the NHG, regular audits of process and laboratory indicators put in place at the PCCs more than a decade ago has resulted in the improvement in glycaemic control over the 4 years. However, the high rate of good glycaemic control amongst the elderly aged 85 years and above is an unexpected and surprising finding, and studies are now being carried out on the risk of hypoglycaemic events that result in unplanned health service utilisation or hospitalisation, a paradox arising from good diabetes care. Other studies have shown that patients with hypoglycaemia experience a poorer quality of life, poor treatment satisfaction and are more likely to report barriers to adherence including being unsure about instructions.^{21,22} An in-depth study into the size of the problem, extent of unplanned utilisation arising from and the causes of hypoglycaemia amongst the elderly is recommended.

Unlike other diabetes registries in Western countries which are based on information gathered annually for the purpose of audits and mandatory reporting,²³ the NHG diabetes registry is an automated central repository of data from every encounter of an identified diabetes patient within the organisation in almost real time. A significant limitation has been the completeness of data on the date of diagnosis and the duration of disease, both fields being prospectively encoded. Nevertheless, the registry data have been proven to provide useful insights and improved the quality of diabetes care.^{24,25} For the health services researcher and policy maker, the NHG Diabetes Registry provides a wealth of information to aid in planning and targeted interventions if we extract maximal knowledge and translate them into improvements. Data can feed into research to estimate future disease burden arising from increasing rates of obesity, ageing, improved care leading to better survival, and rates of diabetes-related complications, will be needed for Singapore, that has hitherto been lacking.

REFERENCES

- Roglic G, Unwin N, Bennet PH, Mathers C, Tuomilehto J, Nag S, et al. The burden of mortality attributable to diabetes: realistic estimates for the year 2000. *Diabetes Care* 2005;28:2130-5.
- National Health Survey 2004. Singapore: Epidemiology and Disease Control Division, Ministry of Health, 2004.
- Principal causes of death, 2005-2007, Health Facts Singapore. Available at: <http://www.moh.gov.sg/mohcorp/statistics>. Accessed 6 July 2009.
- MOH Clinical Practice Guidelines (Diabetes) June 2006. Available at: http://www.moh.gov.sg/mohcorp/uploadedFiles/Publications/Guidelines/Clinical_Practice_Guidelines/Diabetes%20Mellitus.pdf. Accessed 6 July 2009.
- Lim FS, Toh MPHS, Emmanuel SC, Chan SP, Lim G. A preliminary evaluation of a disease management programme for patients with diabetes mellitus and hypertension in a primary healthcare setting. *Ann Acad Med Singapore* 2002;31:431-9.
- Toh MPHS, Heng BH, Sum CF, Jong M, Chionh SB, Cheah JTS. Measuring the quality of care of diabetic patients at the Specialist Outpatient Clinics in public hospitals in Singapore. *Ann Acad Med Singapore* 2007;36:980-6.
- Bodenheimer T, Wagner EH, Grumbach K. Improving primary care for patients with chronic illness. *JAMA* 2002;288:1775-9.
- Gabbay RA, Khan L, Peterson KL. Critical features for a successful implementation of a diabetes registry. *Diabetes Technol Ther* 2005;7:958-67.
- Drolet BC, Johnson KB. Categorizing the world of registries. *J Biomed Informatics* 2007;41:1009-20.
- Toh MPHS, Leong HSS, Lim BK. Development of a diabetes registry to improve quality of care in the National Healthcare Group in Singapore. *Ann Acad Med Singapore* 2009;38:546-51.
- Statistics Singapore – Glossary: Census 2000 Concepts and Definitions. Available at: <http://www.singstat.gov.sg/statsres/glossary/population.html>. Accessed 12 August 2009.
- American Diabetes Association. Standards of medical care for patients with diabetes mellitus. Available at: http://care.diabetesjournals.org/content/26/suppl_1/s33.full. Accessed 6 July 2009.
- Statistics Singapore - Population trends 2008. Available at: www.singstat.gov.sg/pubn/popn/population2008.pdf. Accessed 6 July 2009.
- Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes - Estimates for the year 2000 and projections for 2030. *Diabetes Care* 2004;27:1047-53.
- Yoon KH, Lee JH, Kim JW, Cho JH, Choy YH, Ko SH, et al. Epidemic obesity and type 2 diabetes in Asia. *Lancet* 2006;368:1681-8.
- Ministry of Health, Singapore – First year results of the Medisave for chronic disease management programme CDMP). Available at: http://www.moh.gov.sg/mohcorp/uploadedFiles/Publications/Information_Papers/2008/CDMP%20OP.pdf. Accessed 6 July 2009.
- Adler AI, Stevens RJ, Manley SE, Bilous RW, Cull CA, Holman RR, on behalf of the UKPDS Group. Development and progression of nephropathy in type 2 diabetes: The United Kingdom Prospective Diabetes Study (UKPDS 64). *Kidney Int* 2003;63:225-32.
- Fioretto P, Bruseghin M, Berto I, Gallina P, Manzato E, Mussap M. Renal protection in diabetes: role of glycaemic control. *J Am Soc Nephrol* 2006;17:S86-9.
- Yang X, So WY, Tong PC, Ma RC, Kong AP, Lam CW, et al. Development and validation of an all-cause mortality risk score in type 2 diabetes. *Arch Intern Med* 2008;168:451-7.
- Alvarez Guisasaola F, Mavros P, Nocea G, Alemao E, Alexnader CM, Yin D. Glycaemic control among patients with type 2 diabetes mellitus in seven European countries: findings from the Real-Life Effectiveness and care Patterns of Diabetes management (RECAP-DM) Study. *Diabetes Obes Metab* 2008;10Suppl1:8-15.
- Alvarez Guisasaola F, Tofé Povedano S, Krishnarajah G, Lyu R, Yin D. Hypoglycaemic symptoms, treatment satisfaction, adherence and their associations with glycaemic goal in patients with type 2 diabetes mellitus: findings from the Real-Life Effectiveness and care Patterns of Diabetes Management (RECAP-DM) Study. *Diabetes Obes Metab* 2008;10Suppl1:25-32.
- Vexiau P, Mavros P, Krishnarajah G, Lyu R, Yin D. Hypoglycemia in patients with type 2 diabetes treated with a combination of metformin and sulphonylurea therapy in France. *Diabetes Obes Metab* 2008;10Suppl1:16-24.
- Joshy G, Simmons D. Diabetes information systems: a rapidly emerging support for diabetes surveillance and care. *Diabetes Technol Ther* 2006;8:587-97.
- Kemple AM, Hartwick N, Sitaker MH, Harmon JJ, Clark K, Norman J. Exploring the feasibility of combining chronic disease registry data to monitor the status of diabetes care. *Prev Chronic Dis* 2008;5:A124.
- Weber V, Bloom F, Pierdon S, Wood S. Employing the electronic health record to improve diabetes care: a multifaceted intervention in an integrated delivery system. *J Gen Intern Med* 2008;23:379-82.