Journal of Evaluation in Clinical Practice
International Journal of Public Health Policy and Health Services Research

Journal of Evaluation in Clinical Practice ISSN 1365-2753

Diabetes quality of care at a university community in Beirut

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Keywords
benchmarking, diabetes, electronic health records, medical informatics, patient-centred care, primary health care

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Accepted for publication 16 April 2015

doi:10.1111/jep.12386

Abstract

Rationale, aims and objectives To assess the quality of diabetes mellitus (DM) care provided by a group of family doctors in Beirut.
Methods An observational study, conducted at the American University of Beirut Medical Center–Family Medicine Clinics (AUBMC–FMC), examined the electronic health records (EHRs) of the beneficiaries of the Health Insurance Plan at the American University of Beirut (AUB–HIP) who were older than 20 years ($n = 9469$) in 2009. The eligible population included patients with DM ($n = 701$). Several provider/patient-directed interventions were introduced in the late 2000s, including a comprehensive EHRs system with point-of-care computer reminders, a provider financial incentive based on an annual performance appraisal ranked against that of the US Healthcare Effectiveness Data and Information Set (HEDIS) Comprehensive Diabetes Care indicators, as well as periodic up-to-date training.
Results Optimal control for HbA1c, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, triglycerides and blood pressure were found in 58.6%, 51.0%, 22.4%, 53.3% and 60.2% of the population, respectively. 64.1% and 70.0% received screening for diabetic nephropathy and a dilated eye examination, respectively. When benchmarked against the HEDIS Comprehensive Diabetes Care indicators, the AUB–HIP's quality of care was 13% higher than the average of all plans in the United States. Screening for nephropathy, however, did not reach the above benchmark.
Conclusions Benchmarking served as an important tool in evaluating the current DM care offered and in detecting gaps, yet interventions are recommended for further improvement.

Introduction

The number of patients with diabetes mellitus (DM), mainly type 2 DM, is increasing worldwide [1]. In the United States, the Center for Disease Control and Prevention estimates the prevalence of DM among adults aged 20 years and above to be 11.3% [2]. Similarly, elevated rates of DM have been reported among Arab populations in the Middle East [3]. The prevalence of type 2 DM among Lebanese adults above 40 years of age increased from 8% in the early 1990s to 15.8% in 2005 [3,4]. Also, according to the World Health Organization, the number of Lebanese with DM is expected to increase from 146 000 in 2000 to 378 000 in 2030 [5], taking into consideration that Lebanon is a small middle-income country in the Middle East with an estimated population of around 4 000 000 in the years 2000–2010.

Diabetes care is known to be a challenge because of its complexity. Patients with DM nowadays require multiple medications to control hyperglycaemia and are prone to suffer from other common co-morbidities such as hypertension, hyperlipidaemia and microalbuminuria. That is in addition to the need for DM self-care, smoking cessation, diet and exercise counselling, and other preventive care services [6,7]. Ensuring the control of the different cardiovascular risk factors, including hyperglycaemia, is necessary to reduce the risk of microvascular and macrovascular disease complications and consequently mortality rates [6–11]. Yet in spite of the availability of different potent anti-diabetic medications and clear scientifically evident guidelines, the primary care of patients with DM remains to be suboptimal [12,13]. Data from the National Health and Nutrition Examination Survey have demonstrated little improvement in the control of risk factors between the 1988–1994 and the 1999–2002 surveys, particularly with regard to hemoglobin A1c (HbA1c) and blood pressure (BP) [14]. Studies previously conducted in Lebanon also highlighted the poor control of DM and its co-morbidities [15,16]. This gap in the translation of clinical guidelines into actual practice was reported to be more prominent with DM than with other chronic diseases [17]. Defining optimal DM care is difficult; hence, benchmarking outcomes can serve as a baseline upon which doctors and organizations can depend. This renders DM care outcomes measurable against achievable goals realized in developed health care systems;

therefore, gaps can be detected, and interventions can be tailored accordingly. For instance, the diabetes-related goals for a healthier US population, developed by the National Healthcare Quality Report and reviewed and re-established every decade [18], can be helpful as an international benchmark for DM care.

Objectives

This study aims at assessing the current quality of care provided by family doctors to adult patients with DM benefiting from the Health Insurance Plan (HIP) at the American University of Beirut (AUB), as well as at comparing the adherence to international standards of medical care in DM between the years 1998 and 2009.

Methods

Study population

The electronic health records (EHRs) of all AUB–HIP adult beneficiaries older than 20 years ($n = 9469$) were reviewed for eligibility. The eligible population included patients with DM benefiting from the AUB–HIP in 2009, but excluded those with gestational DM. Patients were classified as diabetic ($n = 701$ in 2009) if already diagnosed, based on the International Classification of Diseases, and/or have been found to have an HbA1c $\geq 6.5\%$ recorded in their EHRs.

Diabetes care-related interventions at AUBMC–FMC

The Family Medicine Clinics at the American University of Beirut Medical Center (AUBMC–FMC) is the health management organization that provides care to the university's HIP beneficiaries, that is, AUB students, faculty, staff and their dependents, serving as the gateway for their various medical care needs. The above-mentioned plan encompasses coverage for all investigations, consultations and in-hospital medical services.

Several provider and/or patient-directed interventions have been introduced at the AUBMC–FMC since 1998 in order to boost clinical preventive services as well as patient health. The first intervention, referred to as the diabetes flow sheet paper, was introduced in 1998 and later followed by the launching of an electronic patient registry (EPR) in 2000. Furthermore, at the beginning of 2009, comprehensive EHRs including a set of evidence-based computer reminders to doctors about overdue preventive services (immunization, screening and diabetes care), were introduced and solely utilized for all data entry (diseases codes, visits, etc . . .), as well as the review of laboratory results and trends. Moreover, in order to compensate for and to overcome any gaps in family doctors' information technology capabilities, doctors were also provided with a printed encounter sheet that included the required preventive care services, tailored to the needs of each individual patient. Also, a provider financial incentive related to the degree of implementation of the required preventive services was adopted. For this purpose, an annual performance appraisal for doctors ranked against that of the Healthcare Effectiveness Data and Information Set (HEDIS) Comprehensive Diabetes Care indicators (All-Plan Mean) was implemented [19]. Furthermore, the family doctors have been receiving periodic and up-to-date training on diabetes care and the latest diabetes guidelines. Family doctors at AUBMC–FMC play the role of gatekeepers, as the subscribers to the AUB–HIP cannot automatically benefit from any health service without having a regular visit with their family doctor first. In addition to the mandatory regular visit with their family doctor in order to benefit from health services, it became mandatory for patients with chronic diseases, who are entitled to medication coverage (49.6% of the target population with DM), to follow-up with their family doctors every 3 to 6 months. Finally, in 2009, a session on the patient-centred approach became an indispensable component of the family medicine introductory course offered to graduate doctors joining the family medicine residency programme.

Study design

This observational study was conducted in February 2010. The eligible population's EHRs were utilized to retrieve the information ever documented about demographic data (age, sex, marital status), smoking status, weight, height, co-morbidities (hypertension, dyslipidaemia, etc . . .), chronic medications, in addition to glycaemic control and cardiovascular disease risk factors monitoring. Patients were considered hypertensive if already diagnosed or found to have elevated BP on two different clinical encounters (systolic BP (SBP) >135 mmHg, diastolic BP (DBP) >85 mmHg). The averages of SBP and DBP documented measurements in 2009 were calculated and used in the analysis. The most recent laboratory results in the year 2009 were retrieved from the AUBMC laboratory database to ensure the availability of the results of tests requested by both AUBMC–FMC doctors as well as the consulted specialists at AUBMC. The data retrieved and results obtained were subsequently compared with similar figures collected in 1998 and to results reported by international studies. The approval of the Ethical Review Committee at AUB was secured prior to the initiation of this study.

Statistical analysis

Data were anonymously entered to SPSS 15 (SPSS Inc., Chicago, IL, USA), and the prevalence of DM among the AUB–HIP population was calculated. Descriptive statistics were utilized to characterize the studied population and to assess doctors' adherence to practice guidelines. Data were reported as means (±SD), or as absolute numbers and percentages. Moreover, percentages were compared using chi-square tests to the 1998 data as well as to international studies.

Results

Prevalence of DM among the AUB–HIP population in 2009

The prevalence of DM among the AUB–HIP population older than 20 years was found to be 7.4% among both males and females, and the highest 10-year age-specific rates were noticed among the age groups 71 to 80 years (26.9%) and 61 to 70 years (21.7%; Fig. 1).

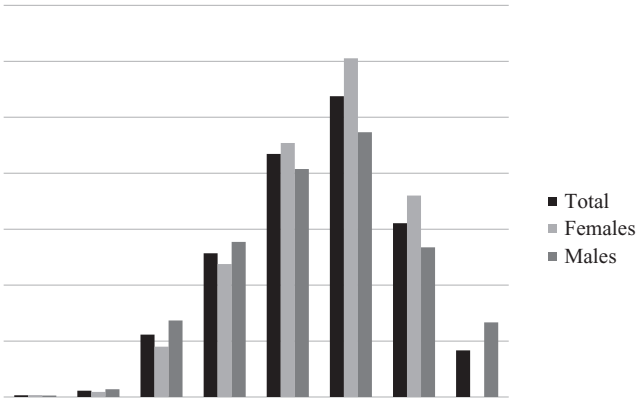

Figure 1 Prevalence of type 2 diabetes mellitus by age and gender among the AUB–HIP population in 2009.

Characteristics of the AUB–HIP population with DM in 2009

The mean duration of DM since the date of EHRs documentation was 7.7 years (±4.1), with 27% of the mean duration ≥10 years. Moreover, the mean age of eligible patients was equal to 65.0 years (±12.1). The prevalence of co-morbidities, namely, smoking, hypertension and dyslipidaemia were found to be 35.5%, 87.4% and 88.0%, respectively. However, the prevalence of overweight and obesity could not be calculated because of the inadequate documentation of height measurements. Among the patients with fully documented and updated medications who are entitled to the AUB-HIP chronic medication coverage [49.6% ($n = 348$) of the population with DM], 67 were on insulin therapy (19.2%): 11 on strict insulin therapy (5 on basal insulin + non-basal insulin, 6 on basal insulin alone), 41 on oral medication(s) + basal insulin, and 15 on oral medications + basal insulin + non-basal insulin.

Documentation of diabetes mellitus pre- and post-2009 interventions

The number of patients with DM older than 20 years of age increased from 539 in 2008 to 701 in 2009. While 38 patients with DM quit the AUB–HIP population in 2008, 51 patients with DM joined in 2009. Moreover, in 2009, 149 patients benefiting from the AUB–HIP were discovered to have new onset DM. Only 4 of the 701 patients had type 1 DM.

Control indicators in 2009 (Table 1)

Six hundred sixty-four out of 701 of patients with DM (94.7%) visited the AUBMC–FMC at least once during the year 2009. The documentation rate of HbA1c results was 97.4%, and the mean frequency of HbA1c tests performed per patient per year was 2.1. The documentation rates of other co-morbidities are illustrated in Table 1. Smoking status was documented for 87.2% of the studied population, among which 28.5% were current smokers. On the other hand, there was a large deficiency in the documentation of some DM-related complications, such as eye complications, neuropathy, other vasculopathies and diabetes foot diseases.

The mean HbA1c for the studied population in 2009 was found to be 7.2. 58.6% of the patients tested reflected optimal control for HbA1c (<7.0), whereas 9.6% revealed very poor control (>9.0). With regard to lipid panel control, the means for total cholesterol, low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C) and triglycerides were 175.3, 102.6, 44.2 and 159.2 mg dL^{-1}, respectively. Moreover, optimal control for LDL-C (<100 mg dL^{-1}), HDL-C (>45 mg dL^{-1} in males and >55 mg dL^{-1} in females) and triglycerides (<150 mg dL^{-1}) were found in 51.0%, 22.4% and 53.3% of the eligible population in 2009 respectively. As for BP indicators, the means for SBP and DBP were 134.3 and 72.4 mmHg respectively, and optimal control was observed in 57.3% and 82.9% of the studied population for SBP (<135 mmHg) and DBP (<85 mmHg), respectively. 64.1% of the studied population received screening for diabetic nephropathy, out of which 54.6% had negative results for microalbuminuria. Finally, a dilated eye examination was documented for 70.0% of the study population.

Discussion

Summary

The prevalence of DM in the current study was 7.4%, 11.1% and 14.7% in subjects older than 20, 30 and 40 years of age, respectively. Although this study did not survey the same patients of the AUB–HIP population in 1998 and 2009 (i.e. no paired data), our results have demonstrated that diabetes care at the AUBMC–FMC has significantly improved between the years 1998 and 2009; the mean age of patients with DM increased from 62.5 to 65.0 years, and there was a significant improvement (P of chi-square test <0.01) in the documentation of HbA1c (39.7% and 97.4%, respectively), albuminuria (6.9% and 64.1%, respectively), annual dilated eye examination (50.0% and 70.0%, respectively) and weight (42.2% and 76.0%, respectively); as well as a better control of HbA1c, total cholesterol, triglycerides and DBP (Table 2) [15].

Strengths and limitations

In spite of not being a population-based research project, this study hosted a relatively large population, which is diverse in terms of the individuals' socio-economic backgrounds, making it quite similar to the Lebanese population.

A cohort study to survey the same patients over years (i.e. paired data) is needed, and this should be feasible taking into consideration the newly implemented EPR. It is also worth mentioning that the AUBMC–FMC nurses and the AUBMC dietitians are not consistently involved in diabetes care and patient education, which weakens the power of a multidisciplinary team care. Future strategies need to address these limitations as well as the documented deficiencies in quality of care and doctor prescribing behaviours, in order to enhance patient comprehensive care and facilitate its continuity.

Comparison with existing literature

The DM prevalence rate detected in this study is slightly lower than the 15.8% prevalence rate previously reported among Lebanese adults older than 40 years in 2005 [3]. Hence, it may be

Table 1 Control indicators of the AUB–HIP population with diabetes mellitus in the year 2009 (n = 701)

	Documented %	Ranges	%	Mean (±SE)
HbA1c (%)	97.4			7.2 (±1.4)
		<7	58.6	
		7–7.9	21.0	
		8–8.9	10.8	
		>9	9.6	
Total cholesterol (mg dL^{-1})	86.0			175.3 (±38.3)
		≤150	25.1	
		<200	75.7	
LDL cholesterol (mg dL^{-1})	86.0			102.6 (±35.0)
		≤70	19.0	
		<100	51.0	
		<130	80.3	
HDL cholesterol (mg dL^{-1})	86.0			44.2 (±13.3)
		>55 in females and >45 in males	22.4	
		≥40	56.8	
Triglycerides (mg dL^{-1})	86.0			159.2 (±83.2)
		<150	53.3	
		<200	80.1	
SBP	84.0			134.3 (±18.5)
		≤130	48.8	
		<135	57.3	
		<140	71.7	
DBP	84.0			72.4 (±11.7)
		≤80	82.7	
		<85	82.9	
		<90	90.1	
SBP/DBP		<140/90	60.2	
Serum creatinine (mg dL^{-1})	85.5			0.88 (±0.48)
Albuminuria	64.1			86.3 (±198.4)
		Absent	54.6	
		Microalbuminuria*	36.1	
		Macroalbuminuria*	7.3	
Dilated eye examination	70.0			

*Microalbuminuria: 30–299 mg g^{-1} creatinine and macroalbuminuria: >300 mg g^{-1} creatinine.

reasonable to consider that the current study may closely emphasize the burden of DM in the Lebanese population. It is thus worth noting the alarming increase in the prevalence of DM (7.4%), which has almost doubled since 1998 (4.1%) among the AUB–HIP population over 30 years of age [15].

When HEDIS Comprehensive Diabetes Care indicators [19] were used to calculate the Diabetes RDI Quality Index of the AUB–HIP in 2009 compared with All-Plan Mean in the United States calculated by the National Care Quality Assurance [20], it turned out to be 1.13, indicating that the AUB–HIP's quality of care for DM was about 13% higher than the average of all plans in the United States (Table 3) [19,20]. Furthermore, this quality index was almost similar to that of Medicare, which was the best 2009 DM care benchmark in the United States (Table 3) [20]. However, in discrepancy to other diabetes care indicators, screening for nephropathy among the AUB–HIP population has significantly improved, yet did not reach the above-mentioned benchmark. This may be explained by several AUBMC–FMC doctors opting not to be strict on requesting this test for a patient who is already maintained on the maximum dose of angiotensin-converting enzyme inhibitors and/or angiotensin receptor blockers.

Different interventions including the comprehensive EHRs, as well as the periodic doctor training in diabetes care and in patient-centred biopsychosocial approach, have likely contributed to the improvement in diabetes care at AUBMC–FMC. Moreover, one cannot ignore the positive effect of updates in diabetes guidelines and in diagnostic criteria, as well as the constant introduction of new anti-diabetic medications with novel therapeutic and combination options. The existing literature seems to be in consensus with regard to the effects of the above-mentioned interventions. For instance, the multifaceted interventions approach that includes EHRs and EPRs, doctor education and reminder system, a regular patient follow-up schedule, regular timely audits, as well as the adoption of patient-focused education and counselling have been found to improve quality of diabetes care in Western countries and particularly the United States [21–27]. Furthermore, EHRs and EPRs were found to play an important role, particularly when their rate of utilization is moderate to high, which is the case at AUBMC–FMC [28]. Finally, benchmarking proved to be a valuable tool for enhancing DM care and attaining critical quality indicators in DM [29].

Table 2 Control of diabetes mellitus and cardiovascular risk factors in AUB–HIP data in 1998 and OPD–AUB data in 2008 versus AUB–HIP in 2009 data

	1998 Population with diabetes benefiting from AUB-HIP[15] (n = 204)		2009 Population with diabetes benefiting from AUB-HIP (n = 701)	
Indicator	Mean	Optimal control %	Mean	Optimal control %
HbA1c % (<7.0)	8.3	28.3*	7.2	58.6
Total cholesterol (<200 mg dL^{-1})	216	34.0*	175.3	75.5
LDL-C (<100 mg dL^{-1})			102.6	51.0
Triglycerides (<150 mg dL^{-1})	208	29.6*	159.2	53.3
BP(mmHg)				
Systolic (<135)	134	55.4^	134.3	57.3
Diastolic (<85)	70	65.7*	72.4	82.9
(<140/90)				60.2
Negative microalbuminuria				54.6
Annual dilated eye examination		22.1*		66.0
Non-smokers				71.5

Comparison made using chi-square for proportion using HIP–AUB data in 1998 and OPD–AUB data in 2008 versus HIP–AUB in 2009 data column, respectively.
P of chi-square: ^$P \geq 0.05$; *$P < 0.001$.

Table 3 Control of diabetes mellitus and cardiovascular risk factors in the HIP–AUB population compared with HEDIS Comprehensive Diabetes Care (Diabetes CDC) indicators Plan Rate, All-Plan Mean*

HEDIS diabetes (CDC) indicators*	HIP–AUB Plan Rate 2009	All-Plan Mean*	Medicare 2009**
HbA1c testing	97.4%	82%	89.6%
HbA1c poor control	9.6%	29%	28.0%
HbA1c control (<8%)	79.6%	64%	63.7%
HbA1c control for selected populations (<7%)	58.6%	44%	43.4%[§]
Eye examination	70.0%	58%	63.5%
LDL-C screening	86.0%	71%	87.3%
LDL-C control (<100 mg dL^{-1})	51.0%	46%	50.0%
Medical attention for nephropathy	64.1%	74%	88.6%
BP control (<130/80 mmHg)	43.3%	29%	33.3%
BP control (<140/90 mmHg)	60.2%	52%	60.5%
Average of all rates	62.0%	54.9%	60.8%

RDI Quality Index* = Plan Average/All-Plan Average = 62.0%/54.9% = 1.13 indicating that this plan's quality of care for diabetes was about 13% higher than the average of all other plans with a similar population.
*Reference: 20.
**Reference: 19.
[§]HbA1C < 7.0 is not present for the year 2009, so the reported one in 2008 was used.

However, although results from the current survey are encouraging, the interventions introduced between 1998 and 2009 were insufficient to achieve all DM control targets. First, the sole utilization of EHRs and EPRs, even if high, does not guarantee high-quality care. Therefore, multiple audits and annual doctor-centred performance feedback may be associated with further improvement. In this regard, Schmittdiel *et al.* emphasized that quality improvement efforts should mainly target clinicians' lack of therapy intensification and patients' lack of adherence to medication [30]. Second, in their 2012 position statement, the American Diabetes Association and the European Association for the Study of Diabetes recommended involving patients in formulating their own health care decisions, as this is believed to enhance compliance with therapy [8]. In other words, the patient should be the final decision maker regarding his/her lifestyle, and to a certain extent, regarding the pharmaceutical interventions used according to his/her preferences, needs and values [8]. For this purpose, proper and comprehensive patient education upon diagnosis, and regularly thereafter, regarding disease progression, management, monitoring, as well as the high probability of needing insulin therapy in the future is critical and imperative in caring for any patient with DM [8,12]. The latter should be done while combating the clinical inertia in insulin initiation and intensification in patients with DM type 2 [31,32].

Implications for research and/or practice

The delivery of DM care is complex, and multiple interventions are required to achieve the necessary improvements. Benchmarking has served as an important tool in evaluating the current DM care offered at AUBMC–FMC and in detecting gaps. Nevertheless, further implementation of interventions such as periodic doctors' performance feedback, enhancement of the patient-centred approach/care with regard to doctor training and clinical practice, including regular comprehensive patient education initiated at diagnosis or even earlier as well as a patients' reminders system, is recommended.

Conflict of interest

The authors declare no conflict of interest.

Ethical approval

The approval of the Institutional Review Board at AUB was secured prior to the initiation of this study.

References

1. Hossain, P., Kawar, B. & El Nahas, M. (2007) Obesity and diabetes in the developing world a growing challenge. *The New England Journal of Medicine*, 356, 213–216.
2. Centers for Disease Control and Prevention (2011) National diabetes fact sheet. Available at: http://www.cdc.gov/diabetes/pubs/pdf/ndfs_2011.pdf (last accessed 6 May 2015).
3. Hirbli, K. I., Jambeine, M. A., Slim, H. B., Barakat, W. M., Habis, R. J. & Francis, Z. M. (2005) Prevalence of diabetes in greater Beirut. *Diabetes Care*, 28 (5), 1262.
4. Hirbli, K. I., Gerges, T. A., Karam, V. J. & Saikaly, J. A. (1992) The estimation of the prevalence of diabetes mellitus in Lebanon. *Le Journal Medical Libanais*, 40 (1), 22–30.
5. World Health Organization (WHO) (2008) Prevalence of diabetes in the WHO Eastern Mediterranean Region. Available at: http://www.who.int/diabetes/facts/world_figures/en/index2.html (last accessed 08 March 2014).
6. American Diabetes Association (2008) Standards of medical care in diabetes–2008. *Diabetes Care*, 31 (Suppl. 1), S12–S54.
7. Inzucchi, S. E., Bergenstal, R. M., Buse, J. B., *et al*. (2012) Management of hyperglycemia in type 2 diabetes: a patient-centered approach: position statement of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care*, 35 (6), 1364–1379.
8. Bakris, G., Sowers, J., Epstein, M. & Williams, M. (2000) Hypertension in patients with diabetes. Why is aggressive treatment essential? *Postgraduate Medicine*, 107, 53–56, 61–4.
9. Fineberg, S. E. (1999) The treatment of hypertension and dyslipidemia in diabetes mellitus. *Primary Care*, 26, 951–964.
10. Gaede, P., Vedel, P., Larsen, N., Jensen, G. V., Parving, H. H. & Pedersen, O. (2003) Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes. *The New England Journal of Medicine*, 348 (5), 383–393.
11. UK Prospective Diabetes Study Group (UKPDS) (1998) Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. *The British Medical Journal*, 317 (7160), 703–713.
12. Saydah, S. H., Fradkin, J. & Cowie, C. C. (2004) Poor control of risk factors for vascular disease among adults with previously diagnosed diabetes. *The Journal of the American Medical Association*, 291, 335–342.
13. Jabbour, S. (2008) Primary care physicians and insulin initiation: multiple barriers, lack of knowledge or both? *International Journal of Clinical Practice*, 62, 845–847.
14. Saaddine, J. B., Cadwell, B., Gregg, E. W., Engelgau, M. M., Vinicor, F., Imperatore, G. & Narayan, K. M. (2002) Improvements in diabetes processes of care and intermediate outcomes: United States, 1988–2002. *Annals of Internal Medicine*, 144, 465–474.
15. Akel, M. & Hamadeh, G. (1999) Quality of diabetes care in a university health center in Lebanon. *International Journal of Health Care Quality*, 11 (6), 517–521.
16. Taleb, N., Salti, H., Al-Mokaddam, M., Merheb, M., Salti, I. & Nasrallah, M. (2008) Vascular complications of diabetes in Lebanon: experience at the American University of Beirut. *British Journal of Diabetes & Vascular Disease*, 8 (2), 80–83.
17. Nobel, J. (2006) Bridging the knowledge-action gap in diabetes: information technologies, physician incentives and consumer incentives converge. *Chronic Illness*, 2, 59–69.
18. National Committee for Quality Assurance (NCQA) (2008) Appendix D: benchmarks from the NHQR: diabetes care quality improvement: a resource guide for state action. Available at: http://www.ahrq.gov/professionals/quality-patient-safety/quality-resources/tools/diabguide/diabqguideapd.html (last accessed 08 March 2014).
19. National Committee for Quality Assurance (2013) How NCQA calculates the RRU quality index. Available at: http://www.ncqa.org/portals/0/hedisqm/RRU/NCQA_Calculates_the_RRU_Quality_Index.pdf (last accessed 6 May 2015).
20. National Committee for Quality Assurance (NCQA) (2010) The state of health care quality. Reform, the quality agenda and resource use. Available at: http://www.ncqa.org/portals/0/state%20of%20health%20care/2010/sohc%202010%20-%20full2.pdf (last accessed 6 May 2015).
21. Nilasena, D. S. & Lincoln, M. J. (1995) A computer-generated reminders system improves physician compliance with diabetes preventive care guidelines. *Proceedings of the Annual Symposium on Computer Application in Medical Care*, 640–645.
22. Renders, C. M., Valk, G. D., Griffin, S. J., Wagner, E. H., Eijk Van, J. T. & Assendelft, W. J. (2001) Interventions to improve the management of diabetes in primary care, outpatient, and community settings: a systematic review. *Diabetes Care*, 24 (10), 1821–1833.
23. Ciemins, E. L., Coon, P. J., Fowles, J. B. & Min, S. J. (2009) Beyond health information technology: critical factors necessary for effective diabetes disease management. *Journal of Diabetes Science and Technology*, 3 (3), 452–460.
24. Hunt, J. S., Siemienczuk, J., Gillanders, W., LeBlanc, B. H., Rozenfeld, Y., Bonin, K. & Pape, G. (2009) The impact of a physician-directed health information technology system on diabetes outcomes in primary care: a pre- and post-implementation study. *Informatics in Primary Care*, 17 (3), 165–174.
25. Peterson, K. A., Radosevich, D. M., O'Connor, P. J., *et al*. (2008) Improving diabetes care in practice: findings from the TRANSLATE trial. *Diabetes Care*, 31 (12), 2238–2243.
26. Weber, V., Bloom, F., Pierdon, S. & Wood, C. (2008) Employing the electronic health record to improve diabetes care: a multifaceted intervention in an integrated delivery system. *The Journal of General Internal Medicine*, 23 (4), 379–382.
27. Dexheimer, J. W., Talbot, T. R., Sanders, D. L., Rosenbloom, S. T. & Aronsky, D. (2008) Prompting clinicians about preventive care measures: a systematic review of randomized controlled trials. *Journal of the American Medical Informatics Association*, 15 (3), 311–320.
28. Pollard, C., Bailey, K. A., Petitte, T., Baus, A., Swim, M. & Hendryx, M. (2009) Electronic patient registries improve diabetes care and clinical outcomes in rural community health centers. *The Journal of Rural Health*, 25 (1), 77–84.

29. Hermans, M. P., Elisaf, M., Michel, G., Muls, E., Nobels, F., Vandenberghe, H., Brotons, C. & OPTIMISE International Steering Committee (2013) OPTIMISE International Steering Committee. Benchmarking is associated with improved quality of care in type 2 diabetes: the OPTIMISE randomized, controlled trial. *Diabetes Care*, 36 (11), 3388–3395.
30. Schmittdiel, J. A., Uratsu, C. S., Karter, A. J., Heisler, M., Subramanian, U., Mangione, C. M. & Selby, J. V. (2008) Why don't diabetes patients achieve recommended risk factor targets? Poor adherence versus lack of treatment intensification. *The Journal of General Internal Medicine*, 23 (5), 588–594.
31. Lakkis, N. A., Maalouf, G. J., Mahmassani, D. M. & Hamadeh, G. N. (2013) Insulin therapy attitudes and beliefs of physicians in Middle Eastern Arab countries. *Family Practice*, 30 (5), 560–567.
32. Kunt, T. & Snoek, F. J. (2009) Barriers to insulin initiation and intensification and how to overcome them. *International Journal of Clinical Practice*, 63 (Suppl. 164), 6–10.