Closing Gaps in Diabetes Care: From Evidence to Practice

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Abstract

Background: Tracking progress in diabetes care may help in evaluating the quality of efforts and identifying gaps in the care.

Objectives: To demonstrate that tracking important clinical indicators of diabetes mellitus can result in improved care as well as help identify and close gaps between evidence and practice in diabetes care.

Subjects and Methods: The study is an observational, random audit of medical records of patients with diabetes who received care at the Diabetes Center, Dammam Medical Complex. Thirteen process and four outcome key performance indicators were studied using the quality improvement Plan–Do–Study–Act model, for the period between October 2012 and March 2016. Individual physician performance was also measured for the same duration. All data were benchmarked against peer organizations worldwide.

Results: Urine examination for proteinuria, foot examination, annual influenza vaccination, aspirin prescription, structured education, personalized nutritional advice and self-monitoring of blood glucose significantly improved between baseline and the final observation of the study (P < 0.001). The proportion of patients with hemoglobin A1c >9% decreased, and that of those who achieved the recommended levels of hemoglobin A1c (<7%), low-density lipoprotein cholesterol (<2.6 mmol/L) and blood pressure (<140/90 mmHg) significantly increased (P < 0.001). Benchmarking against peer organizations worldwide showed comparable results overall, and better results for certain indicators.

Conclusion: Quality improvement strategies and key performance indicators can be utilized to improve the quality of diabetes care delivered, and thus reduce gaps and barriers that exist between recommended diabetes care and practice.

Keywords: Diabetes mellitus, key performance indicators, physician performance assessment, process and outcome indicators, quality improvement

INTRODUCTION

Diabetes is a major public health problem worldwide and is responsible for significant morbidity and mortality as well as increased health-care cost and socioeconomic burden. According to the World Health Organization, in 2012, diabetes directly accounted for 1.5 million deaths...
and indirectly caused another 2.2 million deaths. Of these 3.7 million deaths, 43% were aged <70 years. With a prevalence of 14.4%, diabetes is also an increasingly common condition in the Kingdom of Saudi Arabia (KSA).

Given the complexities of diabetes and its comorbidities, management of diabetes requires a multipronged approach. Studies have shown that achieving the recommended targets for glycated hemoglobin A1c (HbA1c; <7%), blood pressure (BP; <140/90 mmHg) and low-density lipoprotein cholesterol (LDL-C; <2.6 or <1.8 mmol/L if overt coronary heart disease) can help prevent microvascular complications and reduce cardiovascular disease and its associated morbidity and mortality. An annual comprehensive foot examination is recommended for identifying any diabetic foot complications due to diabetic neuropathy and/or peripheral arterial disease. Similarly, periodic eye assessment and screening for kidney damage can help reduce the burden of diabetic retinopathy/blindness and reduce chronic kidney disease-related morbidity and mortality, respectively. Influenza vaccination and patient’s self-monitoring of blood glucose (SMBG) are also important parameters that help in effective management of diabetes.

To help reduce the complexity of managing patients with chronic diseases such as diabetes in primary care settings, health-care organizations are developing models and frameworks to improve the quality of care patients receive. One such method is the Chronic Care Model, which has been shown to improve the quality of diabetes care. Such evidence-based performance measurements utilize indicators that provide standardized and consistent information that help in quantifying improvements in patient care from health-care organizations and/or individual physicians. These findings can also be benchmarked against that of other organizations for comparing efficiency. Indicators are categorized into process measures (which assess the frequency of testing for clinical indicators such as HbA1c, blood lipids, renal function and feet examination) and outcome measures (which include the actual values of the tests and percentage of patients reaching the recommended levels and targets).

There are gaps between evidence and practice, because of which recent advances in diabetes care have not completely translated into optimal medical care received by patients. For example, in the United States, it has been found that 33%–49% of the adults with diabetes do not meet targets for glycemic, BP or cholesterol control, and only 14% meet the targets of all three measures as well as attain a nonsmoking status. Therefore, the objective of the current study was to demonstrate that tracking important clinical indicators of diabetes mellitus can help identify and overcome barriers and gaps between evidence and practice, which would, consequently, result in improved patient outcomes.

**SUBJECTS AND METHODS**

This is an observational audit of active medical records of type 1 and type 2 diabetes patients, aged ≥14 years, who received outpatient care at the Diabetes Center of Dammam Medical Complex, Dammam, Saudi Arabia, between October 2012 and March 2016. In general, patients with diabetes visit a clinic 2–4 times a year; therefore, considering this frequency, only patients who visited our clinics at least once within a year of the data collection period were considered to have active medical records and were included in the study. For evaluation, 12–15 files per physician with a total of 100–150 files per cycle were selected by systematic random sampling; that is, selecting alternate files from the outpatient appointment list. Number of physicians whose files were selected varied between 8 and 12 during the study period. The total number of charts reviewed was approximately 10% of eligible files that met the inclusion criteria. Women with gestational diabetes were excluded.

All selected files were audited for compliance with the clinic’s guidelines developed in accordance with American Diabetes Association’s (ADA) recommendations for the management of diabetes patients (excluding pregnant women). To ensure standardized implementation of guidelines, all staff of the clinic received regular education and updates of any changes in the guidelines as well as a demonstration of the data collection process.

Thirteen process and four outcome key performance indicators (KPIs) were deduced to be the most important from the ADA guidelines and, accordingly, selected for measurement in this study. Individual physician compliance performance was also measured for the same duration. Data documentation for process measures included calculation of body mass index (BMI); BP measurement at each visit; HbA1c measurement twice annually; evaluation of full lipid profile annually, or more frequently if indicated; annual urine examination for proteinuria; comprehensive foot examination, dilated eye examination and influenza vaccination in the preceding 12 months; prescription of aspirin therapy; health-structured education; personalized nutrition advice at first visit, and subsequently as needed; and documentation of SMBG. Outcome measures included achieving target levels of HbA1c, LDL-C, BP and BMI.
Table 1: Guidelines modified from the American Diabetes Association recommendations for the management of diabetes patients (excluding pregnant women)

| Process measures                          | Frequency of assessment                  | Treatment goal or recommended outcome measures                          |
|-------------------------------------------|-----------------------------------------|------------------------------------------------------------------------|
| HbA1c                                     | Twice annually                          | <7%                                                                    |
| Lipids                                    | Annually or more often if needed to achieve goals | LDL <100 mg/dL. In high-risk group with overt CVD, LDL <70 mg/dL. High-density lipoprotein >40 mg/dL, triglycerides <150 mg/dL. Moderate- or high-intensity statin is recommended for ASCVD and ASCVD risk factors, and aged ≥40 years[3,4] |
| Blood pressure                            | Every routine visit                      | <140/90 mmHg                                                          |
| Calculated BMI                            | Every routine visit                      | <25 kg/m²[4]                                                          |
| Comprehensive foot examination            | Annually                                 | NA                                                                    |
| Serum creatinine, blood urea nitrogen, microalbuminuria or albumin-to-creatine ratio | Annually | Either ACE inhibitors or ARBs (but not both in combination) are recommended for the treatment of patients with modestly elevated (30-299 mg/24 h) or higher levels (≥300 mg/24 h) of urinary albumin excretion. NA |
| Dilated eye examination                   | Annually or every 2 years if no evidence of retinopathy | NA                                                                    |
| Influenza vaccinations                    | Annually                                 | NA                                                                    |
| Aspirin therapy                           | Annually                                 | 75–162 mg/day. As a primary prevention strategy in those with diabetes at increased cardiovascular risk that includes most men aged 50 years or women aged 60 years who have at least one additional major risk factor. As a secondary prevention strategy in those with diabetes with a history of CVD[3] |
| Diabetes education                        | At diagnosis (and as needed subsequently) | NA                                                                    |

LDL – Low-density lipoprotein; CVD – Cardiovascular disease; ASCVD – Atherosclerotic cardiovascular disease; ACE – Angiotensin-converting enzyme; NA – Not applicable; ARB – Angiotensin receptor blocker; BMI – Body mass index; HbA1c – Glycated hemoglobin A1c

This study used the time-tested quality improvement Plan–Do–Study–Act model.[14] To increase physicians’ motivation of achieving targets for all process KPIs, the authors set a realistic internal target of 75%.

Extracted data included documented request and/or the result of requested service or investigation for any of the selected indicators for the preceding 12-month period. All data were manually collected by the clinical auditors, who then placed them in a specially designed form for further analysis. The data collection and quality improvement implementation were carried out over 3-month periods. In the first month, the data were collected, analyzed and reported, and in the subsequent 2 months, quality improvement measures and implementation were carried out based on the most frequently occurring process (noncompliance), as per the Pareto chart. The improvement effort was directed to 20% of the process with maximum noncompliance that led to 80% of the effect. Values were expressed mainly as mean and percentages. Unpaired t-test was performed to compare independent sample mean values, wherever appropriate. *P* < 0.05 was considered statistically significant. All physicians working in the Diabetes Center of Dammam Medical Complex took part in the data collection process and peer review of medical records selected by systematic random sampling; that is, selecting alternate files from the outpatient appointment list. Individual physician performance was also measured simultaneously during the peer-review process.

In terms of action, the opportunity for improvement and recommendations were displayed together with collated results and reports in the Diabetes Center’s bulletin board. The Head of the Diabetes Center also provided the report and feedback to each physician, highlighting major areas for improvement and comparing their performances with that of their peers to improve adherence to clinical guidelines and increase the proportion of patients who reach treatment goals. A clinical pathway and algorithm based on the American Diabetes Association’s recommendations for management of diabetes[3,4] were used to aid and remind physicians of the recommendations and standard of care [Algorithm 1].

The entire process was repeated every 3 months until the targets were achieved, after which the process was carried out on a yearly basis to ensure maintenance of the quality performance measures. All results of the process and outcome of the clinical KPIs for the 3.5 years (2012–2016) were benchmarked against the most recent available peers’ organizations from the United States (including Joslin Diabetes Center), United Kingdom, Australia, United Arab Emirates and different parts of KSA.

Ethical approval for this study (RAC number 026) was provided by the Ethical Committee of Dammam Medical Complex on July 25, 2017.

RESULTS

A total of 792 files were reviewed during the study period. All patients were found to have had their body weight, height and BP measured during each visit. Significant improvements were noted for all other processes of care, except for annual dilated eye examination, which slightly decreased from 98% at baseline to 97% at the
end of the study. The mean annual urine examination for proteinuria significantly increased from 78% to 97% ($P < 0.001$). The mean number of patients with diabetes receiving influenza vaccination significantly increased from 0% to 67%, 77% and 79% in the 1st, 2nd and 3rd audit of the study period, respectively, and finally to 81% at the end of the study ($P < 0.001$).

Documented prescription of aspirin significantly increased from 86% to 98% ($P < 0.001$). Similarly, significant improvement ($P < 0.001$) was achieved in the annual comprehensive foot examination (absolute change = 22%), personalized nutrition advice (absolute change = 20%), structured education program (absolute change = 43%) and SMBG (absolute change = 27%) [Tables 2 and 3].

Significant improvements were also found in the outcome variables of diabetes care, with a mean improvement in LDL-C levels $<3.4$ mmol/L ($<130$ mg/dl) from 76% at baseline to 91% at the end of the study ($P < 0.001$) and in LDL-C levels $<2.6$ mmol/L ($<100$ mg/dl) from 52% to 74% ($P < 0.001$). Further, individuals with HbA1c $>9\%$ reduced from 52% to 23% ($P < 0.001$), and those with HbA1c $<8\%$ and $<7\%$ increased from 26% to 56% and from 9% to 37% ($P < 0.001$), respectively. BP $<140/90$ mmHg improved from 59% to 89% ($P < 0.001$). The mean percentage of BMI $\geq 25$ decreased from 91% to 73% ($P < 0.001$), and those with a BMI 18.5–24.9 increased from 9% to 24% ($P < 0.001$) [Tables 2 and 3].

With respect to individual physician performance, all those who scored below the target (75%) at baseline achieved the target in the next review cycle after a discussion on areas that needed improvement. This improvement was maintained above the target throughout the study period [Chart 1]. Benchmarking the process and outcome of clinical KPIs for 3.5 years (2012–2016) against the most recent available peers’ organizations revealed comparable results overall, and better results for certain indicators [Table 3].

**DISCUSSION**

In diabetes care, although extensive guidelines exist, there is a gap between evidence-based recommendations and
There are several physician and patient barriers that contribute to this, some of which are commonly observed, in general, with the management of chronic diseases and some are specific for diabetes mellitus. For physicians, these include lack of time to carry out multiple interventions in a single visit. For patients, adherence barriers include the complexity of treatment protocols and drug therapy, number of treatment options as well as the treatment-related side effects such as hypoglycemia and weight gain. This study demonstrated that it is possible to overcome all these barriers by implementing quality improvement measurement of KPIs. This, in turn, has driven improvements in diabetes care at Dammam Medical Complex.

Several studies have demonstrated that the performance of simpler processes of care can be improved relatively easily; however, these do not necessarily lead to subsequent improvements in important outcomes such as HbA1c, BP and LDL-C. The use of threshold is easily understood and simple to report, but a selection of an appropriate threshold is difficult, especially in the context of recent trials.
Table 3: Benchmarking key performance indicator measures (2012-2016) against peer organizations

| Indicator name                                                                 | Achieved goals at DC-DMC (our results) | KSA overall, 2006[15] | Parts of KSA, 2009[16] | UAE, Dubai, 2004[18,19] | USA, 2000[20,21] | UK, NHS, 2005[12] | Australia, 2011[22] | Benchmark |
|--------------------------------------------------------------------------------|----------------------------------------|------------------------|-------------------------|-------------------------|------------------|-------------------|-------------------|-----------|
| Percentage with BW measured at each routine diabetes visit                      | 100                                    | 100                    | 100                     | 100                     | -                | -                 | -                 | 96        |
| Percentage with BP measured at each routine diabetes visit                      | 100                                    | 100                    | 100                     | 100                     | -                | -                 | -                 | 97        |
| Percentage with HbA1c tests at least twice a year                               | 100                                    | 100                    | 99                      | 100                     | 84               | 96                | 72                | 98        |
| Percentage with Lipid profile tests at once a year                              | 98                                     | 100                    | 98                      | 100                     | 14               | 93                | 78                | 62        |
| Percentage with renal function test every 6 months                             | 100                                    | 100                    | 93                      | 100                     | -                | -                 | -                 | 70        |
| Percentage who received influenza immunization                                  | 67                                     | 77                     | 79                      | 81                      | -                | -                 | -                 | 53        |
| Percentage who received aspirin                                                 | 90                                     | 98                     | 97                      | 98                      | -                | -                 | 45                | 97        |
| Percentage examined for proteinuria at least once a year                        | 71                                     | 90                     | 95                      | 97                      | 31               | 21                | 34                | 38        |
| Percentage with comprehensive foot exam at least once a year                    | 77                                     | 83                     | 81                      | 95                      | 36               | 37                | 70                | 68        |
| Percentage with dilated eye exam at least once a year                           | 98                                     | 97                     | 100                     | 93                      | 97               | 81                | 86                | 63        |
| Percentage who received personalized nutritional advice                          | 73                                     | 88                     | 93                      | 94                      | 94               | -                 | -                 | -         |
| Percentage who received a structured educational program                        | 55                                     | 64                     | 79                      | 100                     | 45               | 52                | 82                | 55        |
| Percentage with glucose home monitoring as indicated                            | 80                                     | 78                     | 95                      | 85                      | -                | -                 | -                 | 55        |
| Percentage with Hba1c level >9.0% (poor control)                                | 52                                     | 47                     | 42                      | 32                      | 23               | -                 | -                 | 21        |
| Percentage with Hba1c level <8.0% (internal benchmark)                          | 26                                     | 48                     | 46                      | 51                      | 56               | -                 | -                 | 47        |
| Percentage with Hba1c level <7.0% (optimal control)                             | 9                                      | 22                     | 23                      | 26                      | 37               | 27                | 10                | 32        |
| Percentage with LDL-C <130mg/dl (3.4 mmol/L)                                    | 76                                     | 83                     | 89                      | 88                      | 91               | -                 | -                 | 65        |
| Percentage with LDL-C <100mg/dl (2.6 mmol/L)                                    | 52                                     | 55                     | 56                      | 65                      | 74               | -                 | -                 | 57        |
| Percentage with BP <140/90 mmHg                                                 | 59                                     | 67                     | 54                      | 82                      | 89               | 16                | 19                | 41        |
| Percentage within targeted BMI of 18.5-25                                       | 18.5                                   | 9                      | 15                      | 24                      | 24               | -                 | -                 | 8         |
| Percentage within BMI >25                                                       | 91                                     | 78                     | 87                      | 75                      | 73               | 92                | 84                | 75        |

BP – Blood pressure; HbA1c – Glycated hemoglobin A1c; LDL – Low-density lipoprotein cholesterol; BMI – Body mass index; BW – Body Weight; DC-DMC – Diabetes Center – Dammam Medical Complex
and recommendations to individualize goals for HbA1c and BP\textsuperscript{[34-37]} Setting individualized goals may make the process of measuring outcome KPIs even more complex. Setting high threshold goals (such as HbA1c <9\% or systolic BP <160 mmHg) reduces poor-quality care and can be appropriately applied to all patients eligible for the measure. However, in most care systems, only a small fraction of patients will fail to meet such a high threshold and would result in false positives.\textsuperscript{[38]} Nevertheless, the quality improvement program in our diabetes center has resulted in significantly improved performance in the selected process and patient outcomes.

In accordance with the ADA’s recommendations and standards of medical care for diabetes patients [Table 1], all patients in this study had their body weight, height and BP measured during each visit. Similarly, all patients also had HbA1c and renal function tested at least twice per year, and in 98\% of patients, full lipid profile was evaluated annually [Tables 2 and 3].

Certain indicators such as improvement in glycemic control and BMI did not reach the desired target of our study, possibly because of factors such as patient behaviors, comorbidity and concerns about medication safety, side effects and cost.\textsuperscript{[39]} Our results are comparable with that of other studies against which the data were benchmarked [Table 3].\textsuperscript{[5,13,15-27]} Data regarding optimal glycemic control of HbA1c <7\% were almost similar to data reported from all other studies, but lesser than the study conducted in the United States. However, when setting a higher target threshold of HbA1c <8\%, the data showed a comparable result to some of the reported data from the United States and better results than that from the United Kingdom and Australia. The results in this study for annual lipid profile evaluation and BP targets were better compared with those reported worldwide; similarly, all process KPIs in this study compare better to other available data [Table 3].\textsuperscript{[5,13,15-27]} This study also revealed significant improvement in SMBG, which could partly be explained by improvement in getting patients more involved in their self-management and providing glucometers to all patients with diabetes as part of the management plan and care. Owing to an existing screening policy at our center, BP, weight and height measurements were carried out for every patient during each visit before seeing a physician. Accordingly, in this study, the mean for these indicators is much higher than other benchmarked studies [Table 3].

The authors believe that a key element that helped the study achieve better adherence with guidelines and improve quality of care was measuring individual physician performance. In this study, all physicians who scored below the set target of 75\% subsequently enhanced their performance after being informed of the areas of care that needed improvement. Therefore, the authors believe that audits of each physician and its feedback and reports were found to be effective in changing physicians’ behavior toward adherence to clinical guidelines, and thus increased the proportion of patients who achieved treatment goals. Audits and feedbacks are intended to enhance professional performance and improve the quality of care and patient safety. In a systematic review including 118 studies, it was found that audits and feedbacks likely improve the performance of health-care providers.\textsuperscript{[39]}

Broader organizational literature also suggests the positive influences of communication, feedback, competence, performance appraisal and reward systems, job security and organizational support and procedures in enhancing decision-making practices.\textsuperscript{[40]} Comparison with peers and rewards for improved results possibly offer additional motivation to physicians and creates a healthy competitive environment. Further, existing evidence has shown the positive impact of health workers’ motivation on retention, performance and quality of care.\textsuperscript{[41]}

From our experience, it can be stated that to overcome barriers and close the gap between current and expected level of performance, a multipronged implementation approach is required. This approach should also result in everyday practice change for sustaining improvements. In our view, encouraging the use of a team-based approach to care management helps disseminate responsibilities over a larger group of health-care professionals and multidisciplinary care. Evidence indicates that effective teamwork in health-care delivery can have an immediate and positive impact on patient safety.\textsuperscript{[42]} Further, proper and accurate clinical documentation also contributes to high-quality care.

Benchmarking has been shown to be a promising tool for improving the quality of care with respect to disease management in type 2 diabetes.\textsuperscript{[43]} The authors believe that because of the competitiveness benchmarking instills through mirroring, it would serve as a key motivational factor for sustained improvements in quality and clinical outcomes.

**Limitations**

Some of the obstacles and limitations of our study were the sample size, the time required to review the paper medical records and manual collection of data. Other limitations include the legibility of handwriting and lack...
of documentation of all delivered care due to the burden of busy clinics in our center and the short consultation time that could have resulted in underestimation of some results. However, considering that the impact of the review improved physicians’ behavior toward adherence to guidelines, and thus improved patient outcomes, the authors believe that the study provides effective results and achieved its aims. Nevertheless, switching to electronic medical recording may make it much easier to retrieve and track patient data than using paper chart reviews. This would also help overcome the problem of legibility of notes, enhance accessibility of data and reduce data collection time.

CONCLUSION

This study demonstrated that gaps and barriers that exist between recommended diabetes care and practice can be reduced through concerted and structured efforts. In addition, measuring individual physician performance and providing them with subsequent feedback enhances their adherence to guidelines and improves patient outcomes. The improvements obtained in this study compare favorably with other organizations against which the data were benchmarked. Therefore, this study provides a framework for developing and implementing public health measures across KSA to reduce the gap between evidence and practice in diabetes care.

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Conflicts of interest

There are no conflicts of interest.

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