Employing the Electronic Health Record to Improve Diabetes Care: A Multifaceted Intervention in an Integrated Delivery System

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INTRODUCTION: Type 2 diabetes is one of the nation's most prevalent chronic diseases. Although well-known practice guidelines exist, real-life clinical performance often falls short of benchmarks.

AIM: Employ an electronic registry derived from a fully integrated electronic health record (EHR) as the cornerstone of an intervention to improve compliance with recommended diabetes performance measures in an integrated practice network.

SETTING: Geisinger Health System's network of 38 practice sites providing care to over 20,000 persons with diabetes located in a 40-county region of central and northeastern Pennsylvania.

PROGRAM DESCRIPTION: A multidisciplinary group of physicians worked to create a "bundle" of best practice measures for diabetes. This measurement tool was then used as part of a multifaceted intervention to improve physician performance in diabetes care, including audit and feedback, computerized reminders, and financial incentives. Changes in performance of individual measures and the total "bundle" were tracked monthly over 1 year.

PROGRAM EVALUATION: Significant increases were seen in all measures of diabetes care over the 12-month period of the study. Vaccination for pneumococcal disease and influenza improved from 56.5% to 80.8% ($p<.0001$) and 55.1% to 71.0% ($p<.0001$), respectively. The percentage of patients with ideal glucose control (HBA1c<7.0) increased from 32.2% to 34.8% ($p<.001$), and blood pressure control (<130/80) improved from 39.7% to 43.9% ($p<.0001$). The overall number of patients receiving all 9 "bundled" measurements improved from 2.4% to 6.5% ($p<.0001$).

DISCUSSION: Diabetes care improved significantly in response to a multifaceted intervention featuring the use of an EHR-derived registry in an integrated delivery system. More work is needed to demonstrate that such improvements will translate into improved patient health outcomes.

KEY WORDS: electronic health record; diabetes care; multifaceted intervention; integrated delivery system.
J Gen Intern Med 23(4):379–82
DOI: 10.1007/s11606-007-0439-2

INTRODUCTION

Diabetes is a chronic illness which requires coordinated medical care and patient self-management to decrease the risk of downstream complications including vascular, renal, and ophthalmologic morbidities. Type 2 diabetes affects approximately 7% of the United States population, and an estimated 26% have impaired fasting glucose. National guidelines for the care of patients with type 2 diabetes are in existence,[1] yet care often fails to meet these guidelines. For example, blood pressure control can reduce the risk of cardiovascular disease among persons with diabetes by 33% to 50%, but in most studies, less than a third of patients exhibit appropriate degrees of blood pressure control. Similarly, compliance with immunizations, cholesterol control, and other performance indicators fall short of ideal. Data collected by the Centers for Disease Control indicates that improved diabetes care is needed. In 2004, just 45.9% of diabetics had influenza vaccinations, 38.8% had pneumococcal vaccinations, and only 68.8% had a hemoglobin A1c measured in the past year (http://www.cdc.gov/diabetes/statistics/preventive/mUSMenu.htm).

What are the reasons for such care gaps? Commonly cited barriers include lack of time during office visits, reimbursement structures that do not incite physicians to focus on prevention, and patient refusal.[2] Yarnall et al.[3] estimated that it would require 7.4 hours per working day for a physician to fully satisfy the US Preventive Services Task Force recommendations for a typical patient panel. In addition, physicians may lack information on their current care gaps, an important initial step in improving performance.

Audit and feedback has been shown to be an effective strategy to improve physician performance of various preventive strategies and guidelines.[4] An electronic health record (EHR) allows such data to be rapidly gathered and presented to physicians. In addition, registries (electronic lists of patients with chronic conditions) can be compiled and used for performance improvement activities "off-line," that is, out of the context of office visits by other members of the care team. EHR systems have been shown to be effective in improving diabetes preventive care through simple reminder mechanisms,[5] but often these reminders and efforts are visit-focused; reminders may then get crowded out of the multiple things that need to be done in a typical office visit.

AIM

The goal of this initiative was to create a registry derived from an EHR to support improvement in both individual measure-

ments and "all-or-none" measures of diabetes care and to evaluate the impact of audit and feedback and the use of EHR-based tools as a part of a multifaceted intervention to improve the adherence to diabetes best practice guidelines.

SETTING

Geisinger Clinic employs nearly 200 primary care physicians in 38 practice locations across central and northeastern Pennsylvania. This network provides over 750,000 outpatient visits yearly to a population of 350,000 patients, including over 20,000 patients diagnosed with diabetes. An EHR has been fully implemented across the network since 2001.

PROGRAM DESCRIPTION

In August 2005, a multidisciplinary workgroup was established and challenged to improve diabetes care for Geisinger patients. To assess the current status of the system's diabetes care, components of care were selected from the American Diabetic Association's "Standards of Care" and reporting sets (such as those from the National Committee on Quality Assurance and the National Quality Forum).[6] These selected criteria were assembled into a "bundle" of measures that were thought to be an ideal goal for most diabetics to achieve. Of the measures selected, nine were easily identifiable from the EHR and became the "diabetes bundle". The results of individual physician's performance, comparisons to national benchmarks, and comparison to peers within our system were first distributed to physicians in December 2005 and then monthly beginning in April 2006.

Geisinger Health System implemented the EPIC® EHR in its primary care practices in 1997. Mining this extensive database for diabetic data required initial accurate selection of "active" patients. The database was sorted using criteria that limited "inactive" and nondiabetic patients selected in error (e.g., those patients screened for a diagnosis of diabetes). We defined an "active" diabetic as a patient who was seen in an office visit in the past 12 months with either a diagnosis of diabetes on the problem list or a diabetes ICD-9 code entered four times in the last 24 months as an encounter diagnosis. Our search identified just over 20,000 diabetic patients over the age of 18 cared for by primary care physicians or endocrinologists in our system. Of the patients, 10,441 (51%) were over the age of 65 with a mean age of 63, and 57.8% were female.

Reports to physicians showed changes in individual criteria and "all-or-none" performance: that is, the percentage of patients who had fulfilled all 9 performance criteria. Also displayed was the distribution of patients partially meeting the bundle criteria based upon the number of criteria met. In addition, tools were created in the EHR to support the process changes needed to complete the diabetic bundle. Health maintenance alerts, best practice alerts, and a nurse rooming tool were rolled out in July 2006. It was up to each individual practice or physician how much these tools were used. The alerts would appear in the patient's encounter, only if the measure had not been fulfilled, to alert the physician that an item was needed.

Physician bonuses were paid if the practices met (or improved to) the diabetes bundle criteria. In October 2005 and April 2006, physicians were paid an additional $500 for improvements in ordering a hemoglobin A1c. In April 2006, physicians were told that the next incentive amount ($750), payable in October 2006, would be based on the completion of the entire bundle. This amount increased to $1,250 for the next 6-month period, in April 2007. Bonuses were also given to support staff for diabetes bundle improvements, as part of an overall staff incentive plan.

PROGRAM EVALUATION

The progress of the intervention was followed by tracking monthly data for each practice site for both individual measures and the overall bundle compliance. Primary care providers with at least 20 diabetic patients in each respective time span (i.e., 12-month look back period) were included in the analysis. Because the endocrine specialty providers were not included in the intervention, they are not included in the analysis. The number of clinicians and diabetes patients ranged from 124 to 136 and 18,511 to 19,494, respectively. The percentage of diabetes patients satisfying each of the individual measures and the percentage satisfying all 9 bundle measures were calculated for each time span. A repeated-measures regression model (Proc Mixed in SAS version 9.1) was used to predict the linear change in percent satisfaction of each outcome measure while controlling for provider and provider clinic. The associated confidence intervals and linear trend p values were the outputs from the results of the regression analysis. p values <0.05 were considered significant.

Figure 1 shows the percent of compliance with the diabetes bundle during the baseline period (March 1, 2005 through February 28, 2006) compared to the performance during each subsequent monthly time period (times 2 through 12). Performance of pneumococcal and influenza vaccination improved from 56.5% to 80.8% ($p<.0001$) and 55.1% to 71.0% ($p<.0001$), respectively. The percentage of patients with ideal glucose control (HbA1c <7) increased from 32.2% to 34.8% ($p=.001$) and blood pressure control (<130/80) improved from 39.7% to 43.9% ($p<.0001$). The overall bundle compliance (i.e., those patients meeting all 9 measures) improved from 2.4% to 6.5% ($p<.0001$). The number of patients who met all 9 bundle criteria increased from 447 to 1,266.

Table 1 shows the absolute numbers of patients impacted for each single-item criteria over time. The largest absolute differences were seen in pneumococcal and influenza immunization. The improvements seen were not uniform over all providers. Figure 2 demonstrates that improvements per provider roughly assumed a "bell-shaped" curve with the range of improvements in the percent of patients having met all bundle measurements ranging from −5% to 13% over the period of study.

DISCUSSION

"All-or-none" performance measures are a recently described way of viewing best practice, which can allow health systems to compare their ability to deliver care at the patient level to "perfect" care. This alternative method of measuring quality can also foster systems perspectives and increase the sensitivity for assessing improvements.[7] For example, in the

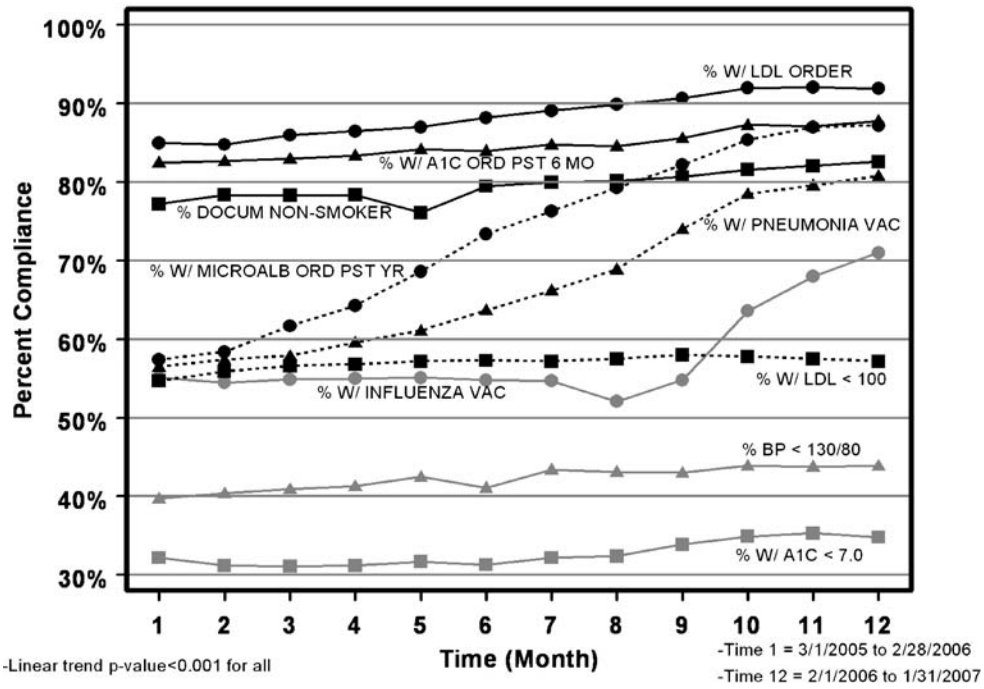

Figure 1. Percent Compliance with Diabetes Bundle Measures from Month 1 to 12

traditional item-by-item method of measuring performance, a practice with the following individual performance measures: pneumococcal immunization of 70%, LDL lowering to <100 of 53%, and blood pressure control to <130/80 of 55%—would have compliance higher than national benchmarks. Yet, when analyzed through an "all-or-none" viewpoint, individual patients in their practices may receive all 3 indicators, on average, only 20% of the time (.70×.53×.55). This method of measurement "raises the bar" for quality improvement efforts and is being used by many large health care systems as an alternative method to measure improvements. In the 2004 National Healthcare Quality Report, item-by-item measurement shows the rates of performance of diabetes standards ranging from 56.5% for influenza vaccination to 93.8% for lipid profiling. However, all measures (five in this report) were recorded as met only 32.1% of the time.[8] Major health systems using all-or-none bundling have reported only 2.4% to 12.8% of patients receiving 7 process measures for diabetes care.[9] Medical groups reporting to the Minnesota Community Measurement project on a 5-component all-or-none diabetes bundle averaged 9.5% in 2006.[10] In the current report, an integrated delivery system was able to make gains in several areas by traditional, single-measure criteria. In addition, all practices had success in improving their performance in a 9-component all-or-none bundle score. It was distressing to our physicians that their 'bundle score' was initially low. We believe that this response created an early momentum for practice change. This low initial score also made it clear that increased physician vigilance and hard work alone would not result in success and encouraged team-based approaches to care.

Most of the literature on changing physician behavior illustrates that multifaceted interventions (such as this one) will be more successful that single interventions.[11] A combination of enabling tools, reminders, audit and feedback, and financial incentives were used in our program. As they were all implemented simultaneously, it is difficult to assess which had the most impact; this is a limitation of the current study. We also

Table 1. Impact of Improvements—Absolute values

Indicator	Number with criteria fulfilled time 1	Number with criteria fulfilled time 12	Difference (absolute number of patients impacted)
BP control	7,496	8,548	1,051
Pneumovax	10,668	15,734	5,066
Influenza	10,404	13,825	3,421
HbA1c <7.0	6,080	6,776	696
LDL <100	10,329	11,138	809

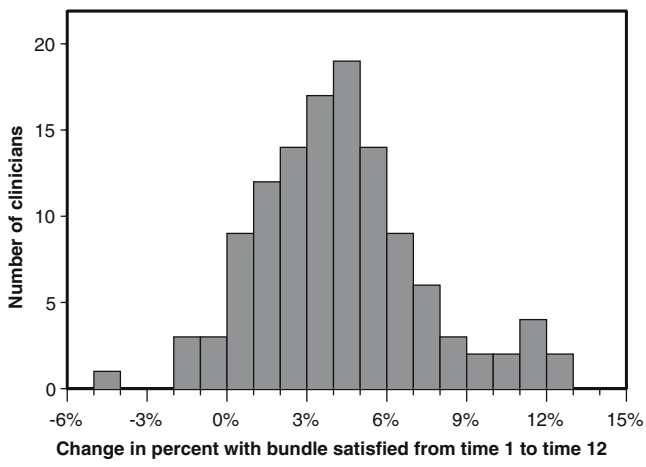

Figure 2. Distribution of clinicians with respect to change in bundle percent during the study period

cannot rule out the contribution of confounding factors such as an increase in physician and patient awareness of diabetes measures, unrelated to the study interventions. Some measures, such as improved smoking, are mostly related to documentation than true improvements in getting smokers to quit. However, we assert that documenting smoking status is an important measure and one which we wanted to improve in the study.

We are aware that improvements in process measures do not necessarily translate into improved clinical outcomes. As illustrated by our results, it is much easier to make sure a patient with diabetes received a LDL order each year, than it is to ensure that the LDL is controlled to appropriate levels. One must extrapolate that improvements in certain process measures, such as immunization percentages, would lead to improvements in mortality and morbidity from respiratory illnesses—and the current work was not designed to assess such clinical outcomes.

Financial incentives often raise concerns about "gaming behavior"—either "cherry-picking" well patients or jettisoning high-risk patients to improve results. Because the number of patients with diabetes did increase during the period of study and we did not see an increase in the number of referrals to our Endocrinology department, it does not appear that patients were deselected. However, one would wonder if the increased awareness of diabetes measures encouraged physicians to diagnose more patients with diabetes earlier—when they could be easier controlled. We are unable to assess the impact of this possibility.

One disadvantage of all-or-none measurement is that all measures receive equal weighting despite the fact that their clinical benefits may differ greatly; for example, lowering blood pressure has stronger effects seen earlier than adding angiotensin converter inhibitors for microalbuminuria. An additional limitation of the present study was the inability to measure some very important performance criteria such as retinal exams and microfilament testing. It is difficult to capture this information in our EHR system, as such items do not appear as discrete data fields.

Critics of "all-or-none" approaches correctly point out that many elderly patients who have multiple diseases or with limited life expectancy cannot be expected to meet all of the bundle measures. For example, a glycosylated hemoglobin of <7.0 might subject such a patient to more risks than are justified by the limited benefit given the shorter period of time for treatment effectiveness. Durso suggests an algorithmic approach to evaluating which patients may benefit from specific recommendations, depending on comorbidities and estimated life expectancy.[12] In addition, patient preferences, polypharmacy, and medication cost and coverage issues speak to the need to individualize care. For these reasons, it is difficult to know what a reasonable goal for optimal performance on the bundle is for our patient population. Future goals of our work include an analysis of patient level correlates with compliance to the quality measures. This may enable us to identify subgroups of the overall population that have the largest (or smallest) improvements over time. This information would allow for future fine-tuning of the intervention and appropriate allocation of resources with the goal of optimizing compliance.

We believe that EHR registries can create tools never before available in medical practice and can be used to galvanize physician-led teams to improve care. In addition, looking at quality data in "all-or-none" fashion may set higher standards for improvement. Medical groups should strive to further refine these methods and continue to work to apply them to improve the care of patients with diabetes and other chronic diseases.

Acknowledgements: *The authors thank Sandra Buckley for her editorial assistance and Dr. Mark Selna for his contributions and coordination of the implementation of the project.*

Conflicts of interest: *None disclosed.*

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