In Brief

Electronic health record-based clinical decision support (CDS) can improve key intermediate outcomes of diabetes care in primary care settings and could be deployed in conjunction with additional care improvement strategies. It is important to understand how to incorporate CDS strategies into primary care practices to obtain high provider use rates and satisfaction. This article describes the process for successful implementation of a CDS tool called Diabetes Wizard.

Outpatient EHR-Based Diabetes Clinical Decision Support That Works: Lessons Learned From Implementing Diabetes Wizard

JoAnn M. Sperl-Hillen, MD, Beth Averbeck, MD, Kevin Palattao, Jerry Amundson, Heidi Ekstrom, MA, Bill Rush, PhD, and Patrick O'Connor, MD, MPH

Electronic health record (EHR)-based diabetes clinical decision support (CDS) systems have great potential to contribute to better diabetes care. However, many prior reports showed disappointing results when such systems were implemented in busy practice settings.

In this report, we *1*) review prior studies that tested the effect of EHR-based CDS systems on intermediate outcomes in diabetes care and *2*) report new findings derived from our experience developing and implementing a novel advanced diabetes CDS system called "Diabetes Wizard" as part of a National Institutes of Health–funded clinical trial to improve diabetes care.

Diabetes Wizard was designed to identify and combat clinical inertia in the management of glucose, blood pressure, and lipids in adults with type 2 diabetes. It was systematically implemented in six randomly allocated intervention clinics in late 2007. Implementation was a multistep, sequential process that was carefully planned and designed to address barriers to successful use of EHR-based CDS systems that were apparent in prior studies.

After implementation, Diabetes Wizard was used at > 60% of all office visits made by adults with type 2 diabetes, and robust use continued after the study period ended. Primary care providers (PCPs) reported high levels of satisfaction with the tool, in terms of both its clinical content and its user interface, which was designed specifically for PCPs. Although the CDS system was designed for PCPs and used technical and numerical expressions, many PCPs showed the printed output to patients and used it as a patient-education and motivation tool. The effect of Diabetes Wizard on intermediate outcomes of care will be reported in a separate publication, but preliminary results appear quite favorable.[1]

Here, we describe the Diabetes Wizard user interface and the process used to implement it so that diabetes nurses, educators, and PCPs may maximize its clinical impact on patients and minimize frustration and disruption at implementation sites.

Obstacles to Better Diabetes Care Quality

There is ample evidence that the quality of diabetes care in the United States is unsatisfactory.[2] In most practice settings, only a minority of adults with diabetes have achieved evidence-based goals for lipid control (LDL cholesterol < 100 mg/dl) or glycemic control (A1C < 7%).[2–4] Further, despite recent evidence that systolic blood pressure is a very strong predictor of both micro- and macrovascular complications in type 2 diabetes,[5] recent studies indicate that only 30–60% of adults with diabetes have reached the recommended systolic blood pressure goal of < 130 mmHg.[6]

Recent studies suggest that 50–80% of macrovascular complications in patients with diabetes could be prevented through adequate control of LDL cholesterol, A1C, and

systolic blood pressure.[7,8] However, < 20% of adults with diabetes have simultaneously achieved all three evidence-based goals.[3] The proportion of patients achieving these goals is consistently lower in endocrinology clinics than in primary care, perhaps because of neglect of blood pressure and LDL control in subspecialty diabetes clinics.[3]

The two principal barriers to better outpatient diabetes care are *1*) patient nonadherence to lifestyle recommendations and drug therapy and *2*) provider failure to intensify drug therapy in patients who are not at the recommended goals. The rate of medication nonadherence in patients with chronic diseases (e.g., diabetes and hypertension) within 1 year after being prescribed a new medication has been estimated at 30–50%[9]; nonadherence to lifestyle recommendations is even higher. We do not comment further here on the problem of adherence other than to note that PCPs provide adequate information (name of drug, purpose, dosage, length of therapy, and major side effects) < 25% of the time when giving a new prescription.[10,11] This statistic suggests that providers must bear some of the responsibility for nonadherence and that changes in provider behavior might reduce nonadherence to some degree.

It is clear from numerous clinical trials and other studies that "clinical inertia," defined as failure to intensify drug therapy at a clinical encounter when the patient is not at the recommended clinical goals, is a second major barrier to better diabetes care. We identified clinical inertia in either glucose, blood pressure, or lipid control in > 70% of adults with poorly controlled diabetes during a 4-month period.[12,13] In a study of 161,697 diabetes patients in California, clinical inertia was noted in 30% of those with hyperglycemia, 36% of those with elevated blood pressure, and 47% of those with elevated LDL cholesterol. This and other head-to-head studies suggest that clinical inertia is a bigger problem than patient nonadherence.[14]

Design of a Diabetes CDS System to Combat Clinical Inertia

EHR decision support systems are, in theory, perhaps the most powerful tool available to combat clinical inertia. However, until recently, most EHR-based CDS systems have improved recommended test rates (e.g., for LDL and A1C levels) but not intermediate outcomes of diabetes care (i.e., control of A1C, LDL, and systolic blood pressure). For example, Meigs et al.[15] reported that an EHR that prompted physicians at Massachusetts General Hospital's clinics to intensify therapy but did not provide tailored or specific pharmacological recommendations (i.e., drug and dose) failed to improve A1C levels. In a Mayo Clinic study,[16] physicians using similar diabetes CDS also increased A1C test frequency but did not significantly lower A1C levels. Findings from other studies are similar.[17–20]

From our experience and other studies, we concluded that diabetes CDS could be improved if *1*) it provided more detailed individualized pharmacological recommendations and *2*) PCPs were given incentives to view the CDS information immediately before or early in a clinical encounter.

Diabetes Wizard CDS Algorithms

Diabetes Wizard was specifically designed to provide much more detailed CDS than what was previously available through reminders or nonspecific action prompts for care. Its principal recommendations pertained to the clinical domains of A1C, LDL, and systolic blood pressure management. Clinical algorithms in Diabetes Wizard integrated data on patient age, sex, current medications, renal function, history of coronary artery disease or congestive heart failure, and a range of the most recent A1C, LDL, and systolic blood pressure results.

A Microsoft Access application was created to allow an expert in diabetes management to create the treatment recommendations for all permutations of these relevant patient conditions. Definitions, queries, tables, and code snippets permitted a match of the recommendations to an individual patient's current state, as extracted from the EHR at the time of the encounter. Microsoft VB 6.0 DLL was used to display the output in a format that could be accessed by one click on the EHR visit navigator.

The result was personalized CDS based on current treatment, comorbidities, and distance from clinical goals, including advice on the drug and dose, suggested clinic visit intervals, and corrective actions for any observed potentially risky prescribing. Diabetes Wizard CDS output was formatted in a highly visual data display that could be understood at a glance and used to plan the imminent visit as a PCP walked into the room (Figure 1).

Implementation of the Diabetes Wizard System

Development of the Diabetes Wizard clinical algorithms and output displays was a major challenge. However, it was clear that most prior CDS efforts had failed because the PCPs never viewed the CDS output early in the clinical encounter. Therefore, a central task in implementing Diabetes Wizard was to modify office workflows and staff responsibilities so that the CDS was placed in the hands of PCPs immediately before diabetes visits.

Six clinics with 20 consenting PCPs within HealthPartners, a large medical group in Minnesota, were randomly assigned to receive the Diabetes Wizard intervention. The clinics had used the Epicare EHR system for years, but the roles of nurses and PCPs had not changed sufficiently to exploit the ability of the EHR to provide diabetes CDS. The Diabetes Wizard was available for all providers in the randomly assigned clinics; however, only physicians who signed an informed consent in these clinics were used to test the full implementation design and to determine outcomes related to its use.

The implementation model that was used to guide clinic implementation of Diabetes Wizard is shown in Figure 2. We found it useful to consider all aspects of the model before implementing Diabetes Wizard, asking ourselves the following pertinent questions related to each of the components necessary to achieve measurable improvements in patient outcomes.

- **Maintain up-to-date evidence-based recommendations:** Are CDS recommendations evidence-based and likely to improve patient outcomes? Are the recommendations complete and up-to-date? Can they be updated easily?
- **Standardized care team roles and process:** Which clinic staff and PCP work processes are necessary at the time of the patient encounter to ensure that Diabetes Wizard CDS output is available and seen by the right care team member at the right time?
- **Communication and measurement:** What kind of communication,

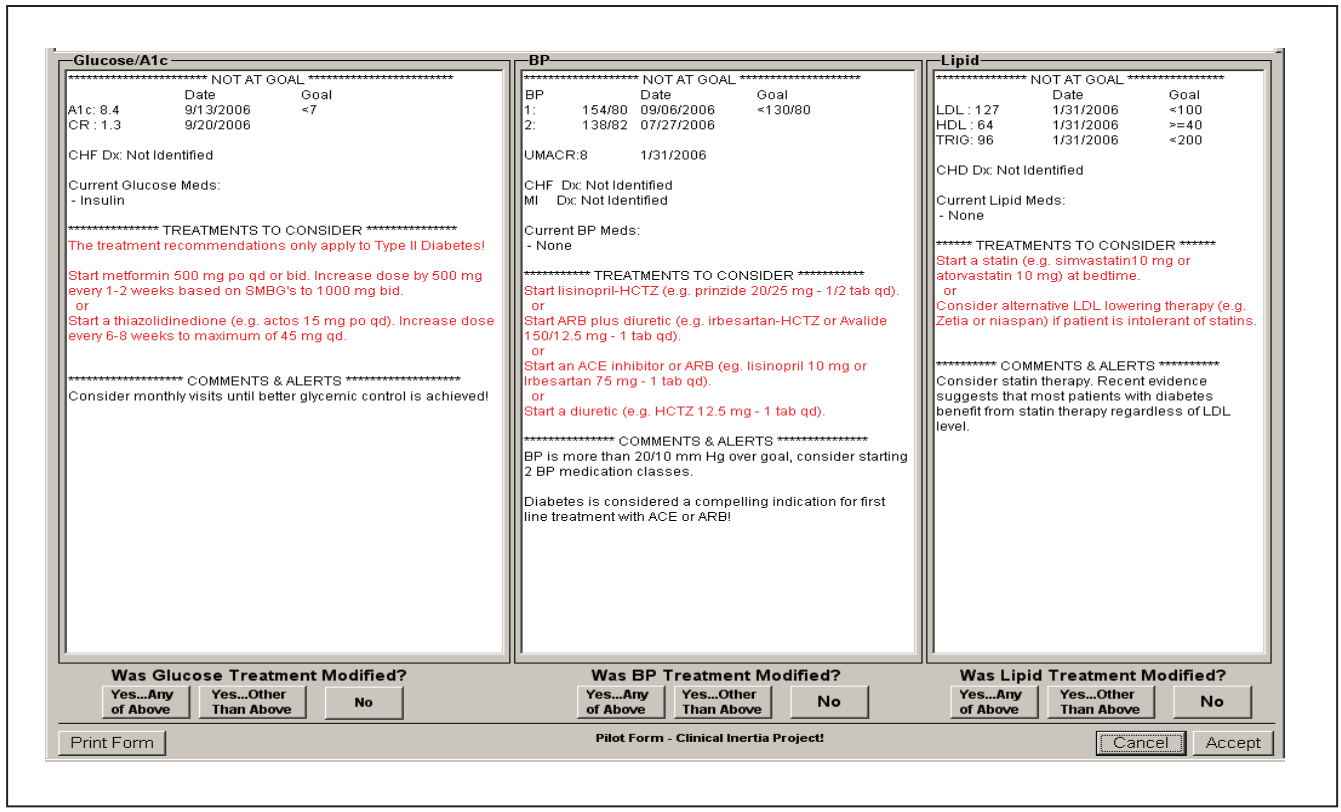

Figure 1. Example of the CDS tool called Diabetes Wizard.

measures of use, tracking, and reminders or incentives will be necessary to ensure targeted levels of utilization?

- **Programming with seamless EHR integration:** What programming will be necessary to develop the tool and integrate it within the existing EHR?

Integral to Diabetes Wizard implementation was a medical group–wide plan to standardize clinic workflows by explicitly defining staff roles and responsibilities. Training for the standardized process occurred at a learning luncheon at each of the intervention clinics and through a simple instruction manual outlining the following steps:

1. After entering the current day's blood pressure into the EHR, the rooming nurse/assistant opens Diabetes Wizard by clicking on a tab prominently located near the vitals tab in the EHR.
2. The single-screen Wizard output (Figure 1) is printed for the PCP to view just before entering the examination room.
3. The PCP reviews treatment options. (The output also could be used as a shared decision-making tool.)
4. Before closing the EHR encounter, the PCP opens the form on the EHR and completes several "visit resolution" questions used to track whether treatment was modified for any clinical conditions not at goal. If treatment was not modified, the provider is asked to select a reason from a drop-down menu.

Key to implementation was communication and buy-in with medical group leadership early in the process. Communication to PCPs occurred later through newsletters, announcements, and e-mails.

A tracking tool was developed to permit measurement of how often the tool was opened and printed; this information was communicated through utilization reports via e-mail to consented PCPs on a monthly basis. The reports graphically displayed individual PCPs' use rate for the previous month. In addition, physicians were paid $800 at the beginning of the study and $800 if they opened the Wizard and completed the visit resolution questions in at least 70% of their diabetes visits in the 6-month study.

Almost all of the physicians (n = 19) completed the visit resolution

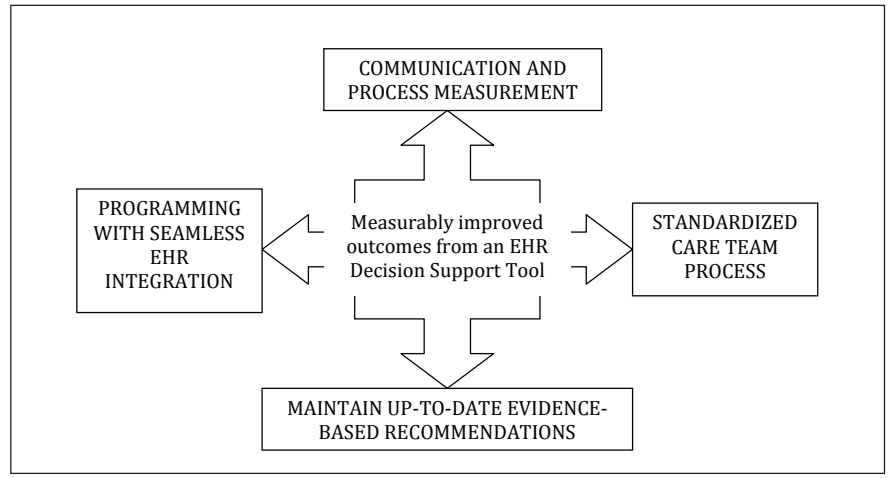

Figure 2. EHR-based CDS Diabetes Wizard implementation model.

Table 1. Satisfaction of PCPs Who Used the Diabetes Wizard EHR-Based CDS Tool

	Completely satisfied (agree)	Somewhat satisfied (somewhat agree)	Not satisfied (disagree)	Completely dissatisfied (strongly disagree)
What is your overall level of satisfaction with Diabetes Wizard?	27% (33%)	72% (61%)	0% (6%)	0%
Are the medications listed on the Diabetes Wizard form accurate?	17% (11%)	75% (56%)	8% (33%)	0%
Are the lab values listed on the Diabetes Wizard form accurate?	58% (33%)	42% (61%)	0% (6%)	0%
Diabetes Wizard treatment suggestions were appropriate from the clinical point of view.	83% (28%)	17% (67%)	0% (6%)	0%
I like the Diabetes Wizard printed format.	20% (11%)	60% (72%)	20% (22%)	0%
I would recommend Diabetes Wizard to other physicians.	82% (29%)	18% (65%)	0% (6%)	0%
I value having the Diabetes Wizard printed for me by my nurse.	17% (24%)	67% (59%)	8% (12%)	8% (6%)

form at least 70% of the time during the 6 months. Physician-identified reasons for no treatment intensification included *1*) patient choice or preference (19.6%), *2*) need for updated A1C (17.3%), *3*) patient of endocrinology or diabetes nurse (14.8%), *4*) addressed dietary/lifestyle changes instead (12.6%), *5*) competing clinical demands (4.7%), *6*) not my patient (3.6%), and *7*) addressed adherence problem (3.6%). Less frequently cited (< 2.5%) reasons were medication regimen already too complex, hypoglycemia concerns, drug intolerance, cost concerns, advanced age or severe comorbidities, referred to endocrinology or diabetes educator, close to goal, and other.

Results of Diabetes Wizard: Utilization and Satisfaction

Overall, physicians were satisfied with Diabetes Wizard and would recommend it to their peers (Table 1). Physicians continued to use the Diabetes Wizard after the study was completed and, although use rates dropped slightly after the utilization reminders and study incentives ended, the tool was still being used by more than half the physicians at about 25–30% of diabetes visits. Preliminary analysis of the randomized trial data also suggested a favorable effect of Diabetes Wizard use on intermediate outcomes of diabetes care, including improved A1C results and some aspects of blood pressure control, despite baseline good diabetes care at the study site clinics.[1] Final data on the impact of Diabetes Wizard on diabetes care will be published in a separate report.

Conclusion

EHR-based diabetes CDS can lead to measurable improvement in intermediate outcomes of diabetes care, with high PCP satisfaction and use beyond an initial period in which incentives were provided. Carefully planned steps are required to maximize use of EHR-based CDS systems, including communication and collaboration with leadership and providers, tracking of utilization rates, and providing feedback and possibly financial compensation or other incentives for use.

Significant programming time is required to integrate CDS into existing EHR systems. Resources are also required for clinical experts to monitor and update clinical content and for programmers to implement updates when needed. Closer involvement and alignment with the major EHR vendors to develop, implement, and maintain advanced CDS systems such as Diabetes Wizard could lead to streamlined implementation and reduced maintenance costs in the future.

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JoAnn M. Sperl-Hillen, MD, is a clinical investigator, Jerry Amundson is a senior systems analyst, Heidi Ekstrom, MA, is a research study manager, Bill Rush, PhD, is a research associate, and Patrick O'Connor, MD, MPH, is a senior clinical investigator at HealthPartners in Bloomington, Minn. Beth Averbeck, MD, is the associate medical director of HealthPartners Medical Group Primary Care at GroupHealth in Bloomington, Minn. Kevin Palattao is vice president of clinic patient care systems at GroupHealth in St. Paul, Minn.