Development and Implementation of a Computer-Generated Reminder System for Diabetes Preventive Care

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ABSTRACT

Diabetes mellitus is a chronic condition with several late complications that can be delayed or avoided through proper preventive health care. Although practice guidelines have been established to improve the preventive care in diabetics, dissemination of these guidelines among physicians and educational programs have been only moderately successful in changing physicians' practice patterns. Previous efforts, however, did not utilize computer-generated reminders. We developed a system of computer-generated reminders for diabetic preventive care. We completed an implementation of the system in the outpatient clinics of internal medicine residents at our institution. This paper describes the development and implementation of this system.

Our results showed that the system flagged an average of 13 items that deviated from diabetes guideline compliance, out of a possible 21 items per patient. The residents completed encounter forms used by the system for 37% of patients seen during a six month period. Physician users exhibited positive attitudes toward the use of guidelines which they judged improved quality at no additional cost of care. However, the complexity and length of the guideline encounter forms and the additional time demands proved to be significant obstacles to current routine use. Our experience will help to improve the system so that it is more usable and acceptable to physicians, especially in the future as health care increasingly makes use of electronic medical record systems.

INTRODUCTION

Diabetes mellitus (DM) is a chronic medical condition which is present in over 11 million persons in the U.S.[1] DM is directly responsible for over 140,000 deaths per year. The disease also contributes to several other causes of death, notably ischemic heart disease and cerebrovascular disease. DM is associated with numerous complications which cause significant morbidity and disability for diabetic patients, and ultimately can lead to their premature death. The medical treatment for DM and its complications is expensive. Treating late diabetic complications costs over $5 billion in hospital charges annually.[2] Although no cure currently exists for DM, experts believe that appropriate medical care can significantly reduce disease complications. Preventive interventions in DM can have substantial impact on health outcomes. [1]

Practice Guidelines for the Care of Diabetic Patients

The American Diabetes Association [ADA] has proposed guidelines for the care of diabetic patients. [3] Adherence to these guidelines could potentially reduce the complications of DM by a significant degree. [1] Thus, the successful implementation of these guidelines into medical practice could dramatically decrease the burden of suffering and the cost of health care for diabetic complications.

Despite the publication of DM practice guidelines and their dissemination to physicians, compliance with the recommended preventive care for DM patients has been low. [4,5] Although previous studies have shown that certain interventions can improve physician compliance with guidelines for diabetes care [6-8], the overall compliance level remained low for many elements of DM care. This low compliance following the dissemination of diabetes guidelines is similar to results from other guideline compliance studies, even those involving simple guidelines. [9] The complex decision-making logic required to apply diabetes guidelines in routine practice is likely to be an important reason for the observed low compliance rate.

The use of computer-generated reminders is one method that has been shown to be effective in improving physician compliance with practice guidelines for preventive care.[10-11] This method uses a computerized patient database and decision logic derived from selected practice guidelines to create reminders or prompts to physicians about recommended services for each patient. Computer-generated reminder systems have been successful in improving immunization rates, and screening rates

0195-4210/94/$5.00

for cancer, hypertension, and hypercholesterolemia [10,11]. The observed improvement in compliance is typically 10 to 20% more than that of control programs involving only education and monitoring. The key element of the computer-generated reminder intervention is the timely, individualized feedback that is given to the physician. At the present time, an evaluation of computer-generated reminder systems using diabetes care guidelines has not been reported.

This paper describes a stand-alone, computerized reminder system for seven interrelated DM preventive care guidelines. We evaluated the system's initial implementation with internal medicine residents in outpatient clinics. We also assessed the medical residents' attitudes about the system and about DM practice guidelines.

METHODS

Computerized Reminder System Development

1) Guideline selection and development: Individual guidelines for preventive care in DM were selected from those published by the ADA [3]. Additional guidelines were then identified from a review of available DM literature. The complications of DM can be divided into seven broad categories [3] :

macrovascular disease (coronary heart disease, peripheral vascular disease, and stroke)
nephropathy (chronic renal failure)
neuropathy (peripheral and/or autonomic)
retinopathy (severe vision loss or blindness)
foot disease (infections requiring foot amputation)
improper glycemic control (ketoacidosis (DKA) and hypoglycemia).
complications of pregnancy (congenital malformations and perinatal mortality)

The selected guidelines were organized into six categories corresponding to the above groupings of DM complications. Since our project was initially targeted at patients in internal medicine clinics, the pregnancy category was not directly addressed. The six guideline categories were:

- **Glycemic control**
- **Foot care**
- **Eye care**
- **Renal care**
- **Macrovascular care**
- **Neurologic care**

Each category was further divided into items performed at each visit and items performed annually or less frequently than every visit. The guidelines were then phrased concisely and assembled into flowcharts which presented the clinical decision logic and the necessary elements of care for each category.

A study group was organized which consisted of rural Utah physicians, physician assistants, and faculty members from the Department of Internal Medicine at the University of Utah. This group analyzed the flowcharts which were constructed from the guidelines selected originally. The study group made suggestions for changes in wording and content of the guidelines. The guidelines were also simplified and condensed in order to allow the easiest incorporation into the primary-care practice setting. These changes resulted in a set of revised guidelines and revised flowcharts for each of the six categories.

2) Encounter forms development: The clinical data needed to determine compliance with the revised guidelines and to drive the clinical decision logic were grouped into seven **encounter forms** to be used for data capture. Six of the forms, one for each of the six guideline categories, were designed to capture data from annual patient evaluations. The seventh encounter form was designed to collect data about care which should be performed at every visit. Most items on the encounter forms were simple Yes/No questions (for example: "Patient is currently on ADA diet"). The remaining questions had blank spaces for the written entry of numeric values such as laboratory test results ("Fasting blood glucose is ___"). The number of questions on a single form ranged from 5 to 15 and the seven forms together contained a total of 68 individual questions.

3) Computer algorithm and patient database development: The decision logic from the revised flowcharts and the data elements from the seven encounter forms were incorporated into a computer program written with Symantec C++ for the Macintosh. The program serves as an object-oriented longitudinal patient database for storing clinical information related to the revised DM guidelines. Data entry into the database is via a graphical user interface with dialog windows that are identical in structure and content to the seven encounter forms. This design is intended to facilitate data entry by a clinic clerk to whom completed encounter forms are returned by the physician. Baseline information about each patient (from manual chart review) and the responses to questions on any of the encounter forms are stored in the database for each patient, along with the date the information was recorded. Previous entries for an individual patient can be reviewed sequentially on the screen to verify the accuracy of the reminders generated by the program.

4) Health Maintenance report generation: The computer program uses the currently available data for a given patient to generate a printed paper **health maintenance (HM) report** for the patient's primary physician. This report includes demographic information, a summary of the patient's current DM preventive-health status, a schedule of upcoming or

past due preventive-health activities for the patient, and clinical alerts about high-risk aspects of the patient's current profile. The report is intended to be placed on the front of the patient's chart so that the HM information will be available to the physician at the next clinic visit by the patient.

Implementation of the Reminder System

1) Recruitment of participants: All second and third years internal medicine residents at the University of Utah were oriented to the content of the developed guidelines, the encounter forms to be used, and the process of using the reminder system. Each of these residents sees patients in a weekly general internal medicine clinic at either University Hospital (UUMC) or the Veterans Affairs Medical Center (VAMC) in Salt Lake City. Thirty-five of the 36 residents agreed to participate in the pilot study which took place during the six months between October 1993 and April 1994.

2) Identification of diabetic patients: An attempt was made to identify all patients with DM at each of the sites who had a scheduled clinic visit within six months after the start of the project. The study included patients if they had been diagnosed with DM (Type I or II) and had been seen in one of the clinics or hospitals within one year prior to the initial data collection. Newly diagnosed patients and those receiving care at specialty clinics for diabetes were excluded. The main data sources used to identify DM patients were ICD-9 codes from hospital discharges and clinic billing lists, pharmacy records of diabetic medications, and laboratory data of patients with elevated blood glucose or hemoglobin A1c.

3) Putting the system into action: a cycle of feedback to the physician and capture of patient data: In this study, individualized feedback is given to each physician about preventive services that are recommended for each of their diabetic patients. This required a system of ongoing data collection about the services that the patient has received. The process is started by entering baseline patient data from a manual review of the patient's hospital and clinic charts into the computerized database. This information is used to generate an initial HM report about the patient with suggestions for preventive services that were overdue or planned. The report is placed in the patient's chart prior to the next clinic visit. At the time of this visit, the physician is given encounter forms to complete as appropriate for the patient. Following this, the physician returns the completed encounter forms for entry of data into the patient database. The new patient information is then used to generate a new HM report. This report would in turn guide the next preventive services that are provided to the patient, and the cycle would continue on from there.

4) Evaluation of the acceptability of the system: In order to assess the acceptability of the computer-generated reminder system by the physicians, a questionnaire was developed to determine physician attitudes to various aspects of the project. The usability of the encounter forms and the HM reports, the time required to incorporate the system into practice, and perceived obstacles to guideline compliance were addressed. Suggestions for system improvement were also solicited.

RESULTS

Implementation of the Reminder System

There were 221 patients initially identified with possible DM scheduled at the UUMC, of which 88 were scheduled more than once during the pilot study period. At the VAMC, there were 259 possible diabetic patients scheduled, of which only ten had more than one visit. Once the patients had been identified, an attempt was made 1) to locate and review their medical records, 2) to enter their DM related data into the computer database, 3) to generate an initial HM report, and 4) to place the report into their clinic charts prior to the scheduled visits.

Problems in the overall use of the system in this study included unavailable patient charts, canceled or rescheduled appointments, and failure to place the HM report in the patient's chart before a clinic visit. Because of these problems, only 49% of the initial diabetic patients identified were seen by a resident with the HM report available for review. This resulted in 93 patient visits at the UUMC and 141 visits at the VAMC available for evaluation.

The process of baseline chart review took an average of 15 to 20 minutes per chart to abstract the diabetes guideline related data. The time to enter the abstracted baseline data into the patient database was approximately ten minutes per patient. The generation of the initial and subsequent HM reports took an average of 30 seconds. Data entry from a completed encounter form into the patient's database required less than 45 seconds for an experienced data-entry person. The time necessary to complete a single encounter form by an uninterrupted physician was approximately 1.5 minutes.

The data from baseline chart review resulted in the identification of a substantial number of diabetes guideline items that needed attention by the physician to bring the patient's care into compliance. An average of 13.2 preventive care recommendations out of a possible 21, or 63%, were flagged for each chart. The categorization of items is shown in Table 1.

Table 1: Average Number of Preventive Care Recommendations Flagged per Patient following Baseline Chart Review

Category	UUMC	VAMC	Max.*
Eye Care	2.0	1.7	3
Foot Care	2.1	1.8	3
Glycemic Control	3.7	3.7	5
Macrovascular Care	1.6	1.7	3
Neurologic Care	1.7	1.8	2
Renal Care	2.1	1.5	4
Routine Visits	0.8	0.5	1
Total	13.9	12.5	21

* Max. = maximum possible flags for the category

Participation by the Resident Physicians

The number and type of encounter forms filled out and returned by the residents are shown in Table 2. The residents' participation declined after the first two months of the project, particularly at the VAMC clinics. The Routine Visit forms were completed more frequently at both sites (chi-square=18.3, $p<0.01$ for UUMC; chi-square=1.9, p=NS for VAMC), probably because this form was on the same sheet as the HM report. Overall, 37% of patients had one or more encounter forms completed and returned. On the average, there were 1.63 forms completed per patient visit. Specific reasons given for not always completing the encounter forms included lack of time during the clinic visit, lack of understanding of the use of the forms, lack of clarity about where to return forms, sub optimal organization of form content, and too many other existing paper forms to complete.

Table 2: Number of Completed Encounter Forms

Encounter Form Name	UUMC	VAMC
Eye Care	31 (33%)	16 (11%)
Foot Care	30 (32%)	19 (13%)
Glycemic Control	39 (42%)	19 (13%)
Macrovascular Care	30 (32%)	18 (13%)
Neurologic Care	30 (32%)	19 (13%)
Renal Care	31 (33%)	18 (13%)
Routine Visits	58 (62%)	24 (17%)
One or More Forms	60 (65%)	26 (18%)
Total Patients Identified	**93**	**141**

Acceptability of the System by the Residents

The acceptability questionnaire was completed by 33 of the 35 participating residents. The results revealed that at least 85% of the residents agreed that practice guidelines improved the quality of care and assisted physicians in providing care. Seventy percent did not believe that guidelines increased costs, and 70% did not think guidelines reduced the time it took to provide patient care.

While over half of the residents found the encounter form questions to be organized into useful groups appropriate for patient care, over 70% thought that the forms were difficult to use and did not reduce the time it took to provide care. The HM report was thought to be organized, accurate, and appropriate by over half of the residents. However, 74% did not think the report reduced time spent on patient care. Both the HM reports and the encounter forms were found by over 80% of residents to provide helpful reminders of aspects of DM care, and 35% believed this caused a change in their patient management.

The majority of residents believed that each of the categories of preventive care for DM had important effects on reducing long-term complications, and over 70% believed the glycemic control, foot care, and eye care had this effect. Over 75% of residents thought that each component of care (history, physical, lab, education, referrals) had an important impact on long-term outcome, with 88% finding patient education to be important.

Ninety percent of residents believed that the care they currently provided was in accordance with current recommendations, however, 77% also believed that their care would be improved by the use of practice guidelines. Over 80% thought that the guidelines used in this project were applicable to the diabetic patients they treat.

We found a number of differences between the UUMC and VAMC residents in their responses to the acceptability questionnaire. Although the small sample size did not allow these differences to reach statistical significance, there were six questions for which the VAMC and UUMC respondents differed by over 20%. For these six, the VAMC residents gave the encounter forms a less favorable rating. Compared to the UUMC group, the VAMC residents thought the encounter forms were more difficult to understand and use, made it more difficult to record patient care, increased the time it took for patient care, and were less appropriate for patient care than the UUMC residents. The VAMC residents also did not believe that attention to glycemic control, renal care, and neurologic care in diabetics had as strong an effect on long-term outcome as the UUMC group.

DISCUSSION

In this paper, we have described the development and implementation of a system of computer-generated reminders for diabetes preventive care. The system was effective in identifying and flagging an average of 13 diabetes guideline recommendations that required action by the physician to bring patient care into compliance. Once baseline data on a patient is entered, the system provided feedback about the current guideline compliance and generated a list of recommended preventive health services that were

due. Typical visits required completing 2 of the 7 encounter forms, requiring less than 2 to 3 minutes. The forms could generate electronic medical records, actually reducing future documentation time.

The deficiencies in guideline compliance identified by the reminder system suggested a great potential for improved diabetic patient care with the use of the system. The seemingly low level of participation by the residents in this pilot study must be viewed within the context of intended system use. Since most of the diabetes guidelines are recommended at yearly intervals, the physician does not need to complete all seven encounter forms at every visit. If, for each diabetic patient, the physician completes eight to ten forms over a period of one year, the patient's care should be in compliance with the guidelines. Assuming the patient is seen four times a year, the residents in this study were participating at a level that could achieve compliance within one year. The complexity of the diabetes guidelines make it likely that certain services will be done by the physician often while others will be omitted in many patients. The reminder system that we have described can organize the preventive care guidelines for the physician to allow the delivery of timely and comprehensive diabetes preventive care.

Most residents believed that the guidelines: improve quality of care, have a beneficial effect on long-term outcomes, were appropriate for their own patients, and provided helpful reminders for many aspects of patient care. The residents did not respond positively to the organization of the forms or the extra time it took to complete them.

FUTURE DIRECTIONS

The findings of this study suggest a number of ways that this system can be improved. The use of encounter forms and HM reports in this study was problematic but in the future will not be needed as these guidelines become data-driven by electronic medical record systems. For the present, these paper forms should be reorganized and simplified to make them easier to understand and use. Getting specific input from the intended users will help to design forms that are more likely to be completed. More time should be spent giving a detailed orientation to clinicians on the mechanics of using the system and ways for them to incorporate it into their patient care routine. The training and support of clerical and nursing staff in the clinics would help in this regard. Also, direct entry of appropriate data by the patient, nurse, or clinic clerk could reduce the paperwork burden on the physician and increase acceptability of the system. Providing feedback to physicians about their relative performance in guideline compliance compared to their peers and their progress in achieving compliance could serve as an incentive to increase their use of the system. The ongoing development of an electronic medical record will greatly improve the utility of this system by making routinely collected patient data available to help drive the HM reminders. Once these changes are made, the system will become more readily used by clinicians, and the potential improvements in preventive care for diabetic patients can be realized.

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The authors would like to acknowledge Iona Thraen, Shelley Wood, and Charlene Weir for their assistance with this project, and Lee Min Lau for editorial suggestions.

This project was funded in part by the Special Fellowship in Ambulatory Care provided through the Department of Veteran's Affairs Medical Center in Salt Lake City.