Impact of a Diabetes Electronic Management System on the Care of Patients Seen in a Subspecialty Diabetes Clinic

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OBJECTIVE — To compare the compliance with diabetes care performance indicators by diabetes specialists using a diabetes electronic management system (DEMS) and by those using the traditional paper medical record.

RESEARCH DESIGN AND METHODS — A DEMS has been gradually introduced into our subspecialty practice for diabetes care. To assess the value of this DEMS as a disease management tool, we completed a retrospective review of the medical records of 82 randomly selected patients attending a subspecialty diabetes clinic (DC) during the first quarter of 1996. Eligible patients were defined by the suggested criteria from the American Diabetes Association Provider Recognition Program. During the first quarter of 1996, approximately one half of the providers began using the DEMS for some but not all of their patient encounters. Neither abstractors nor providers were aware of the intent to examine performance in relationship to use of the DEMS.

RESULTS — Several measures were positively influenced when providers used the DEMS. The number of foot examinations, the number of blood pressure readings, and a weighted criterion score were greater ($P < 0.01$) for providers using the DEMS. There was evidence, although not statistically significant, for lower mean diastolic blood pressures ($P = 0.043$) in patients and for number of glycated hemoglobins documented ($P = 0.018$) by users of the DEMS.

CONCLUSIONS — Performance and documentation of the process of care for patients with diabetes in a subspecialty clinic are greater with the use of a DEMS than with the traditional paper record.

It has been shown in numerous studies that the process of care for patients with diabetes is deficient (1–3). In an attempt to improve the quality of care for people with diabetes, the American Diabetes Association (ADA) has begun a program of provider recognition for providers whose standards of care are consistent with the ADA's published consensus statements and guidelines (4).

Disease management strategies for chronic disease are designed to foster the consistent application of care guidelines in a cost-efficient manner. The goal is to do the right thing, at the right time, all the time. Patients with diabetes have unique barriers to care. Diabetes affects almost every body system. In addition, care extends over the lifetime of the patient and includes multiple visits with numerous health care providers, often within many health care systems. The patient with diabetes frequently has many competing illnesses at each clinical visit, making it difficult for the provider to consistently comply with published guidelines and recommendations.

The traditional paper medical record does little to help facilitate management of diabetes care. The health care provider spends an excessive amount of time during a clinical visit retrieving old data and acquiring new information. Because the paper record does not routinely provide a timely display of aggregated data as a disease management view, it does not facilitate the time needed to adequately document the encounter, assess the status of the patient, and plan appropriate counseling, testing, and referrals. Because of this problem, a variety of strategies, such as flow sheets, reminder cards, and patient record books, have been used to supplement the paper record, facilitate the recognition of key clinical data, and prompt the provider (and patient) to comply with standards of care (5–11).

Computer-based reminder systems have been stated to be a prerequisite for improvement of diabetes health care (12,13). To date, the use of computers and computerized databases in disease management of diabetes has usually been limited to two main strategies. Because of the lack of computerized clinical data sets, one strategy for health service evaluation has been to use insurance claims and billing data to provide data on utilization (14–16). The approach of using an administrative data set designed for purposes other than quality improvement (i.e., billing) has been driven by the time and expense of a medical record review. Quality information obtained from these legacy data sets is limited, and interpretations using only this type of data are often biased because of the lack of associated clinical information. An alternative strategy has been to construct data sets for the development of diabetes registries and collection of quality indicators (5,17–24). These data sets are in addition to the paper record, require significant time and expense for separate data entry (either from worksheets completed by the provider or from a

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Received for publication 31 October 1997 and accepted in revised form 24 February 1998.

Abbreviations: ADA, American Diabetes Association; DC, diabetes clinic; DEMS, diabetes electronic management system; SMBG, self-monitoring of blood glucose.

medical record review), and rarely provide feedback to the provider and patient during the course of a clinical visit.

We have previously reported on a prototype diabetes electronic management system (DEMS) that is used in real time by the provider during the clinical visit (25). By concentrating on the human–computer interface and aggregating data according to clinical assessment and administrative tasks, we have been able to construct a robust system that offers potential advantages in disease management that are not seen with the use of the paper record. This system has been gradually introduced into our clinical practice during the past several years. This transition from a paper record to DEMS afforded us the opportunity to examine the effect of the use of the DEMS as compared with the paper record on compliance with the processes of care for diabetes in a subspecialty diabetes clinic (DC).

RESEARCH DESIGN AND METHODS

Population

Sample size and eligible patient definition were consistent with recommendations from the ADA Provider Recognition Pilot Project. The study sample included established adult patients with diabetes seeking continuing care from a group of 19 board-certified endocrinologists and one nurse-practitioner in a subspecialty DC. During the first quarter of 1996, 1,235 patients (16 years or older) seen in this DC were identified electronically from billing data by *International Classification of Diabetes, Ninth Revision*, diagnosis codes 250.00–250.93, 362.01, 362.02, 366.41, and 357.2 as having a diagnosis of IDDM or NIDDM (confirmed by medical record review). To be eligible for the study, patients must have had a diagnosis of diabetes for a minimum of 1 year before the DC visit date. They must also have had a DC visit coded for diabetes in the prior 12–24 months. Based on these criteria, there were 238 qualified patients having an identifiable service visit during the 3-month period. From this group, 82 patients were randomly selected for medical record review.

DEMS and paper medical record

The DEMS is designed to allow entry of clinical information (real time) as the provider is in the room with the patient (25). It is structured to allow an empowered data-entry person to enter information before the provider's encounter with the patient. The information entered by the data-entry person varies and can include chief complaint, vital signs, current medications, and completed referrals since the last encounter. An electronic interface with laboratory data systems allows the automatic entry of diabetes specific core laboratory data. Depending on the clinical schedule and the preference of the provider, the data-entry person may or may not assist the provider in entering the data. When information has been entered into the DEMS before the provider sees the patient, the provider reviews this information and makes additions or corrections based on his or her interview with the patient. All other information is entered by the provider during the course of the encounter. Predetermined responses in the form of pick lists, radio buttons, etc., minimize the need for keyboarding or transcription. The paper medical record is requested for the clinical encounter; however, many providers begin the encounter with the patient before the paper medical record is available. This happens because the provider does not immediately need the paper record to complete the encounter and it shortens the patient's stay in the clinic. At the end of a clinical encounter, the DEMS generates a report for the paper medical record and the patient. For this study period, the DEMS allowed the provider to set goals and the timing and frequency of clinical process activity expected for the patient.

Providers using the paper medical record only followed their traditional process of documentation, not unlike other paper medical records. This process allowed an unstructured entry of free text (usually handwritten or dictated) to document the findings during the provider encounter. A pre-evaluation person assisted the provider in gathering of data similar to that for the DEMS, but the provider was responsible for including this information in his or her documented note. Our paper medical record is integrated and includes laboratory, subspecialty, hospitalization, and correspondence notes. In this paper record, there is a running list of dismissal diagnoses. While there was no attempt to provide checklists or reminder systems for specific guideline activity within the body of the paper medical record; providers using either the DEMS or the paper medical record only during the encounter with a patient were equally subject to guideline implementation efforts that were ongoing during the study period (e.g., immunization strategies). For the purposes of this study, the reviewing nurse abstractors used documentation found only in the paper medical record. Providers for the randomly selected patients were equally represented. The provider's use of the DEMS or the paper record only was determined only after the selection process. Because of this, some providers fell in both the DEMS and paper record only groups.

Performance indicators

Each medical record was reviewed comprehensively (by one of two trained nurse abstractors) for documentation of compliance with the performance indicators suggested by the ADA Provider Recognition Program. A measurement manual was developed by the principal research team, listing the indicators that were measured and their definitions. The intent of this manual was to document the interpretation of the definitions of the ADA provider recognition performance indicators as they specifically applied to the unique aspects of our health system, before the medical record audit. An electronic audit tool was developed for the recording of performance indicators from the audit as defined by the measurement manual. Many fields in the audit tool included edit checks based on the definitions found in the measurement manual (e.g., validation of index visit date, validation that the patient met eligible patient criteria). To assess interrater reliability (and validity of medical record abstraction using the measurement manual and audit tool), the first 10 records were reviewed by both abstractors, and agreement in coding was 100%. The study team and reviewers were not told of the intent of comparing performance of providers using the paper record or DEMS. Patients were classified as having type 1 or type 2 diabetes by their physicians.

Data parameters documented during the 12 months before but not including the service date included clinical process, laboratory, and counseling. Clinical process indicators included the following: the number of blood pressure measurements recorded and values of diastolic and systolic pressure, the number of foot examinations, and documentation of whether a dilated eye examination was completed by an ophthalmologist or optometrist. Up to six blood pressure measurements were entered for this 12-month period. Reports of blood pressure taken at home were not included and if more than one blood pressure measurement was taken at a visit, the average was used.

Table 1—*Weighted criterion score for quality indicators*

	Score
Major	
Eye examination in the last year	10
Smoking status and advice to quit	10
Two or more glycated hemoglobin measurements in the last year	10
Two or more blood pressure measurements in the last year	10
Lipid profile in the last year	10
Urinalysis and if negative for protein then microalbumin measure	10
Foot examination in the last year	10
Minor	
Diastolic blood pressure <90 mmHg	5
Glycated hemoglobin <8%	5
Nutrition education in the last year	5
Diabetes education in the last year	5
Total score	90

The laboratory parameters completed during this same period included documentation that the patient was performing self-monitoring of blood glucose (SMBG), quantitation of urinary microalbumin excretion, the number and value of glycated hemoglobin measurements, and a lipid profile (total cholesterol, triglyceride, and HDL cholesterol).

Indicators of performance in counseling included documentation of tobacco use and evidence of advice given to quit, immunizations (pneumococcal and influenza), diet documentation and education, and diabetes management education.

Analysis and statistics

Statistical Analysis System (SAS) served as the analysis tool for the database. Comparisons between patients whose providers used the DEMS and those who used the paper record only were based on χ^2 tests for percentages and Wilcoxon's rank-sum tests for ordinal and continuous variables. All data in texts and tables are shown as mean ± SD.

To control for multiple testing, we used a weighted criterion score (Table 1). This score was constructed before analysis, based on consensus (face validity) from an independent body of health care providers (generalists, diabetes specialists, educators) and health policy planners (ADA Provider Recognition Pilot Project). In addition, we elected to accept only P values <0.01 as indicative of significant differences between groups.

RESULTS — Table 2 lists the demographic characteristics of the patients studied. Of the 82 patients, 17% had type 1 diabetes and 65% were taking insulin (7% were receiving oral agents and insulin). The 39 patients whose providers used the DEMS did not differ from the 43 patients whose providers used the paper record only with regard to age, sex, type of diabetes, diagnosis of hypertension, and the type or frequency of use of diabetes medications.

Table 3 compares the performance indicators for the two groups. Most parameters appeared to be positively influenced when providers used the DEMS. The number of foot examinations and the mean weighted criterion score were significantly increased in patients whose providers used the DEMS. The number of blood pressures documented was greater (P = 0.0035) and mean diastolic blood pressures were lower (although not significant at $P < 0.01$) in patients whose providers used the DEMS. In addition, there was a trend for an increase in the number of glycated hemoglobins ordered (P = 0.016).

CONCLUSIONS — Computer systems have been reported to facilitate disease management (5,12,13,26,27). However, these systems have most often provided aggregated reports or reminders for meeting selected processes of care, as a supplement to the medical record. These and other systems often require additional support and processes for data entry that occurs outside the setting of the clinical encounter. It has been suggested that computer-generated clinical data sets will become a decision support tool as valuable as the stethoscope when the data entry is done by the provider and patient concurrently during a clinical encounter (12,13,23,25,26). We report that the use of such a system (DEMS) significantly enhances the documentation provided by board-certified specialists in the care of patients with diabetes. While we do not report a specific cost-benefit analysis with this study, the fact that the providers who used the DEMS were subject to the same health system infrastructure, appointment scheduling processes, and productivity demands as providers who used only the paper medical record suggests that the use of the DEMS is at least cost neutral. Additional studies are needed to understand its impact on cost savings.

This study has two major limitations. Providers were not randomized to use of

Table 2—*Characteristics of patients cared for by providers using the DEMS and providers using paper record only*

Characteristic	DEMS	Paper record only
n	39	43
Age (years)	62.4 ± 12	60.0 ± 17
Male	20	25
Type 1 diabetes	7	7
Type 2 diabetes	32	36
Diagnosis of hypertension	19	20
Treatment		
Diet (only)	1	2
Oral agent	11	15
Insulin	24	23
Insulin and oral agent	3	3

Data are *n* or means ± SD.

Table 3—*Performance indicators for patients whose providers used the DEMS compared with the paper record only*

	DEMS	Paper record only	*P* value
n	39	43	
Blood pressures per patient per year	3.6 ± 1.6	2.7 ± 1.6	0.0035
Diastolic blood pressure	80.6 ± 9.6	93.6 ± 25.0	0.043
Systolic blood pressure	138.3 ± 16.9	140.9 ± 19.6	NS
Foot examinations per patient per year	2.9 ± 1.1	1.8 ± 1.4	<0.001
Dilated eye examinations in last year	64.1	65.1	NS
Documentation of SMBG	100	100	NS
Measurement of urinary microalbumin	30.8	27.9	NS
Four glycated hemglobins per year	76.9	51.2	0.016
Most recent glycated hemoglobin (4–7% normal range)	9.7 ± 1.7	10.2 ± 1.9	NS
Lipid profile in last year	71.8	65.1	NS
Tobacco status and advice to quit	97.4	95.4	NS
Diet documentation	100	95.4	NS
Diet education	66.7	55.8	NS
Diabetes self-management education	94.9	90.7	NS
Mean weighted criterion score	66.3 ± 12.9	55.4 ± 16.5	0.0025

Data are means ± SD or %.

the DEMS. Thus, the differences observed may not relate solely to use of the electronic versus the paper record. As with many new devices or surgical procedures, demonstration of efficacy of the DEMS in a randomized trial must be preceded by efforts aimed at optimal implementation of this new approach to management. It is encouraging that this study demonstrated beneficial effects in a setting in which providers are already motivated and knowledgeable about the principles of optimal diabetes care. Because the majority of patients with diabetes are cared for by nonspecialists, the translation of our findings to the primary care setting will be important. A second issue relates to whether the observed differences were due to true differences in practice patterns or merely reflective of improved documentation through use of the DEMS. Documentation of care is an essential part of good medical practice. It is critical in assessing clinical processes as they relate to outcomes. The question regarding the impact of the DEMS (or any other decision support tool) will only be answered with appropriate documentation. Our study, taken together with previous studies (5,22,23), suggests that computerized medical record systems can improve provider compliance with care guidelines.

We have shown that a DEMS and supporting clinical systems in a subspecialty clinic assists the provider in complying with standards of care. Performance and documentation of the process of care was greater with the DEMS than with the paper record. Additional studies are needed to confirm these findings. Hopefully, systems that improve process not only will enhance compliance with standards of care but also will improve medical outcomes in the years ahead. Further studies are required to address this important question.

Acknowledgments— This study was published in part as an abstract at the 16th International Diabetes Federation Congress, 20–25 July 1997, and was supported by funding from the U.S. Public Health Service (DK29953), Novo Nordisk, Copenhagen, and the Mayo Foundation.

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