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The Effect on Cost of Medical Care for Patients Treated with an Automated Clinical Audit System

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An automated clinical medical record and audit system was developed to evaluate the effect of modifying physician behavior at the control points in the ambulatory care process and to determine if this change was reflected in patient care cost outcomes. This study compared clinical and cost results of patients in an experimental group, who had the automated record and audit system, to a control group, who had a traditional clinic record without chart audit. Physicians responded to the automated audit suggestions at a rate of 50.25 in the experimental group and 37.3 in the control group. No major differences were observed in clinical outcomes, with the exception of the number of days of hospitalizations and, consequently, the cost of hospitalizations. The experimental group cost for hospitalizations was one-third of the control group and accounted for a majority of the differences in the total annual cost for the two groups.

INTRODUCTION

Computer-based medical records for ambulatory care have been in use for over 15 years. The initial systems were developed to address problems of eligibility, structure, and content of information in the traditional medical record. Early in the course of the development of computer record systems it was discovered that while the above problems were helped, several new areas of concern became apparent that were not due solely to the traditional format of the medical record. Studies of automated medical records systems found that obvious clinical abnormalities were overlooked and reasonable preventive medicine measures were not being practiced.[1] Several clinical studies employing medical algorithms and protocols were developed to test the hypothesis that health provider behavior could be changed. The majority of these studies showed that there was generally improvement in the quality of medical care as measured by recording of clinical data

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needed to carry out explicit process criteria, discovering more significant pathology, and ordering relevant clinical tests for specific abnormalities.[2–4]

Because of the success of these studies, Automated Medical Record Audit Systems (AMRAS) have been developed in an effort to do a more thorough job than a manual review, and to quantitate and study how such automated algorithms or protocols might influence outcome of patient care. Several studies have now shown that with automated audits, providers followed 50 to 75% of the suggestions when a possible intervention was pointed out by the computer review system. However, only 20 to 30% of the recommendations were followed when a protocol input was not given to the provider in the control group.[4,5]

AMRAS sets a standard of care to achieve a desired process that is assumed to be related to outcome. Preliminary experience of this system shows that physician action is modified with AMRAS. This change occurs in the direction of meeting minimal levels of care by enhancing compliance with protocols containing those elements of care that are considered efficacious and necessary for successful treatment outcome. It is anticipated that AMRAS exerts a "streamlining" or tightening effect of the diagnostic and therapeutic process and that these processes and improvements will measurably effect the cost of care.

Few studies have examined the cost factors in clinical protocol systems (computer or noncomputer), and those that are available in general have focused on nonphysician providers, e.g., nurse clinicians, physician extenders, and short-term patient problems.

One main objective of this study was to evaluate the effect of AMRAS by modifying physician behavior at the control points in the ambulatory care process—ordering diagnostic tests, prescribing therapeutic regimens, recognizing clinical problems early—and to determine if this change is reflected in the utilization of several identifiable resources that can be expressed in terms of dollar costs.

The data presented in this paper are preliminary results of an 18-month study of 305 patients entered into the study. Data presented will focus on cost outcomes for the first year for 185 patients who have completed the majority of the study and who have all clinical cost information available.

MATERIALS AND METHODS

Study Clinic

The study patients attended the University of Texas Medical School Ambulatory Clinic, where they received primary care. The majority of these patients have been coming to this clinic for years, and physicians care for these patients as private patients. The patients see the same physician each visit. House staff and medical students also see the patients, but always with the attending physician responsible for the patient.

The clinic meets 3 half days weekly and is located in a medical professional building. The clinic staff includes, at each session, one or two attending diabetic specialists, one resident, one or two nurse clinicians, zero to two medical students, one registered nurse, one L.V.N., one dietitian, and one teaching nurse. The same registered nurse and diabetic

teaching nurse worked with this group of patients throughout the study and always recorded the patients' vital signs and blood samples and collected study data according to fixed protocols.

Release of information was obtained so that data could be obtained from several sources in and outside of our system.

Automated Medical Record Audit System

The computer-based medical records system used in this study was developed by this research group in 1972 and has been used continuously since then. Over 7,000 patient visits have been processed and more than 60 physicians, nurse clinicians, and medical students have used the system. The system has been described in detail in previous publications.[6]

The computer programs in this system are written in FORTRAN/extended for a CDC Cyber 172 computer having 131K byte core. Three programs are used in the total medical record chart review system. The first is an edit program, which checks for both alphameric and inappropriate keypunch data. The second program is an automated medical record update program, which merges prior medical information and current medical information to create an updated file that then generates a report of the most recent information from the patient's medical record. This medical record is utilized by the physician for the patient's clinic visit and for clinical decision making. The third program is the record audit program, which uses the latest updated file and contains protocol-driven algorithms and prints a report for the physician. The present file data base consists of approximately 190,000 80-byte records and is the input to each of the programs above. The programs run on an off-line system.

Two days before each clinic session, automated chart audits are obtained for each patient in the study scheduled to attend the upcoming clinic. The entire tape file on each patient is reviewed prior to recommendations being generated. Eighty percent of the automated chart audit suggestions are for recommendations concerning general medicine and preventive care and the remainder are for specific specialty problems. During routine computer review a new patient with an extensive data base may have 20 to 30 suggestions covering several deficiencies or problems. After a patient has been in the system for several months, approximately 3 to 5 suggestions per visit are made. For a usual clinic attendance of 30 patients, each record is reviewed in advance by the computer, and thus, approximately 3,000 items are checked and 60 to 120 suggestions are made to physicians.

Study Design

The design selected for this study was a strict experimental design using control and experimental groups. Patients were assigned to these groups through the use of stratified random samples. Patients were stratified on diabetes, hypertension, and obesity, and any combination of these, and method of diabetic control—insulin, oral agents, or diet alone. Specific information was also collected on certain variables expected to put patients at risk such as retinopathy, nephropathy, and cardiovascular disease. Sample size was calculated to give an alpha level of .05 and a beta of .9.

Over a period of several months, 305 patients entered the study. The experimental group had the AMRAS and the control group the traditional medical record with no chart audit. The clinical and cost data for the second group is processed by computer, but the printout is retained in the research laboratory and is not available to clinic personnel. This is to keep the master computer tape up-to-date for chart review and cost-analysis studies. All patients had an initial 3-month phase in period with the traditional medical record to negate any of the effects of previous automated medical records that were available in the patient's chart. Several sets of strict criteria were established for eligibility and maintenance in the study.

All clinical data were standardized as much as possible by usual criteria for establishing a diagnosis and control of the problem(s).

Method of Data Collection

A medical research assistant interviewed each patient for every visit during the study. The assistant collected all information and tests performed during the physician–patient encounter and questioned the patient as to any visits or examinations he/she had previously or by another physician or clinic, hospitalization, emergency room visits, and medications. All study data were then coded and entered into the automated medical record system. Several different billing systems were queried at 6-month intervals to determine patient–physician encounters and costs. In addition, letters were sent to other physicians to obtain copies of their medical records and charges on a routine basis.

Patient outcome measurements include the number and type of clinic visits, the number and reasons for emergency room visits, the number and reasons for hospitalizations, and the actual values for study parameters such as blood pressure, obesity, and glucose. Significant events that occurred to the patient during the study period, such as stroke, foot ulcers, amputations, myocardial infarctions, and diabetic ketoacidosis, were recorded from the actual record and examined by several physicians to verify diagnosis, reasons for admission, etc.

Cost-related data were obtained in all cases from actual patient bills that were generated by automated billing systems and in some cases by manual billing systems. Actual charges were entered in each specific category or subcategory.

PRELIMINARY RESULTS

A total of 305 diabetic patients began the study. At the time of this paper, 185 patients have completed the first 12 months, in which cases detailed costs and clinical data are available. The remaining 120 patients are still in the study. Of the 185 patients, 133 (71.9%) completed this phase of the study (Table 1).

Table 2 shows the results of the automated medical record audit suggestions made and followed by physicians. The study group (AMRAS) had a rate of 50.25 of the suggestions followed, and the group with no chart review 37.3.

There were no statistically significant differences observed in the number of visits to the diabetes clinic (4.6 ± 1.5 vs. 4.8 ± 2.05), other clinics, glucose, blood pressure,

Table 1.

	Chart audit system	No chart audit system
Number of patients began study	85	100
Dropped	27	25
Completed study	58	75
Died	3	4

Table 2. Chart Audit 12 Months

	Chart audit system	No chart audit system
Number of patients	58	75
Number of visits to diabetes clinic	266	360
Suggestions made	784	1291
Suggestions followed	394	482
Rate followed (%)	50.25	37.3 $p < .001$

Table 3. Ambulatory Care Costs

	Chart audit system	No chart audit system
Number of patients	58	75
Office visits	$ 8,712	$12,269
Laboratory, X ray, ECG, etc.	$ 5,884	$ 6,925
Procedures	$ 1,832	$ 2,260
Emergency center	$ 3,543	$ 3,037
Total	$19,971	$24,491
Average cost/patient	$ 344	$ 327

weight control, and emergency room visits. Medication and travel costs plus indirect costs were not completed at the time of this report. The ambulatory care costs are shown in Table 3.

The major cost difference between the groups was in hospitalizations. Table 4 demonstrates that number of hospitalizations and number of days hospitalized are significantly different.

Hospitalizations account for the major cost difference in total costs and average cost per patient/year between the groups (Table 5).

The annual cost of processing the automated record and audit system is shown in Table 6.

Table 4. Hospitalizations

	Chart audit system	No chart audit system
Patients hospitalized	12	20
Percent of patients hospitalized	20.7	26.7
Number hospitalizations	20	41
Days hospitalized	196	594 p .005
Mean/*SD*/days hospitalized	9.8 ± 11.6	14.5 ± 16.7
Total costs	$92,378	$260,990
Cost/hospitalization	$ 4,619	$ 6,366

Table 5. Total Costs

	Chart audit system	No chart audit system
Number of patients	58	75
Outpatient costs	$ 19,971	$ 24,491
Inpatient costs	$ 92,378	$260,990
Total	$112,349	$285,481
Average cost per patient/year	$ 1,937	$ 3,806

Table 6. Annual AMRAS Cost

Item	Cost
Medical Technician (1/3 time)	$4,400
Data entry equipment	$1,128
Supplies	$ 720
Computer (off line)	$1,967
Total cost for 305 patients	$8,215
Cost/patient visit for 12-month study	$ 5.77

DISCUSSION

Preliminary results of this study demonstrate that physicians responded to automated audit suggestions in the study group at a rate of 50.25 and 37.3 in the control group without the aid of audit or suggestions. These data are consistent with previous studies by this group and others and were the basis of modifying physician behavior at the control points in the ambulatory care process. Does this change affect diagnostic and therapeutic processes to measurably effect the cost of care?

On the basis of previous studies of this same patient population, we feel that the two groups were balanced as much as possible in regard to the multiplicity of disease and risk factors found in diabetics.

In this relatively small group of patients there were no major differences observed in control of glucose, blood pressure, obesity, and number of office visits. This finding has also been discovered in previous studies but with study periods of only 12 months. There is a difference between the groups in the number and days of hospitalizations and consequently the cost of hospitalizations. This finding supports the same results discovered in a previous study of this group of patients.[7] In this study, hospitalizations accounted for $92,378 in the chart audit (study) group and $260,990 in the nonaudited (control) group and was the major cost item in both groups.

More detailed statistical analysis is required to state that an automated chart audit system has the potential to prevent or alter a major problem in the care of a diabetic patient and decrease hospitalizations. If this holds up in the final analysis of all data, the cost impact could be considerable and could justify the relatively high cost of $5.77/visit for processing the clinical data. At a time when medical care costs are one of the major concerns in health care, additional study should continue to find any method to control cost of care while not sacrificing the quality of care but improving it instead.

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