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Refereed paper

Clinical informatics to improve quality of care: a population-based system for patients with diabetes mellitus

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ABSTRACT

Background The prevalence of diabetes mellitus is increasing in the USA. However, control of intermediate outcome measures remains substandard. Recently, significant emphasis has been placed on the value of electronic medical records and informatics systems to improve the delivery of health care.
Objective To determine whether a clinical informatics system improves care of patients with diabetes mellitus.
Methods In this quality improvement pilot initiative, we identified 48 patients with diabetes mellitus who were due for their annual haemoglobin A1c (HbA1c), low-density lipoprotein (LDL) and microalbumin tests. Through our newly developed clinical informatics initiative, patients were reminded to schedule tests and a physician appointment. Seventy-five patients without reminders served as controls.
Results A significant improvement in LDL control was achieved in the intervention group (35.4% vs 13.3%; P=0.004). The intervention group had a greater percentage of patients who underwent the three tests, and members of this group also showed greater control of haemoglobin A1c, but these differences were not statistically significant.
Conclusions A clinical informatics system, used to deliver proactive, co-ordinated care to a population of patients with diabetes mellitus, can improve process and also quality outcome measures. Larger studies are needed to confirm these early findings.

Keywords: clinical informatics, diabetes mellitus, quality of health care

Introduction

The prevalence of type 2 diabetes mellitus is rising in the USA. Thirty-eight percent of US citizens born in 2000 are predicted to develop type 2 diabetes mellitus during their lifetime.[1,2] Diabetes contributes to greater morbidity and mortality and is currently the sixth leading cause of death in the USA.[3] Not only does diabetes management consume considerable time and resources for individual medical practices, it also accounted for 11% of total US healthcare expenditures in 2002.[4,5] Despite new technologies and guidelines to improve the process and care of patients with diabetes mellitus, many studies have shown that the control of glycaemia, lipids and blood pressure is dismal and has improved little in the past decade.[6–13] The control rate of HbA1c in patients with diabetes has continued to be approximately 8% for the nation.[6,7,10–14] Many factors contribute to suboptimal control, including lack of co-ordinated care, poor adherence to prescribed pharmacologic and non-pharmacologic care plans, clinical inertia, and reimbursement policies that do not cover non-visit care.[6,15–19] In addition, traditional primary care models with a standard panel of patients per physician do not allow enough time to provide all the care recommended by the United States Preventive Services Task Force (USPSTF) guidelines, which detail preventive services and management of chronic diseases.[20,21]

Registries and clinical decision support systems have been proposed to help primary care providers transfer the delivery of preventive services and overdue tests for patients with chronic conditions such as diabetes mellitus to their team members. This improves care and reduces the burden on primary care providers in the USA, who typically have only 15 minutes per patient visit.[22] This is especially critical in the current model of care because a primary care physician is estimated to need about 18 hours per day to provide all recommended preventive and chronic care services to a typical patient panel. Consequently, only half of evidence-based care is actually provided.[23,24]

We previously reported that our redesigned care process, which involved work with allied health staff, standardisation of care, and use of an electronic, web-based tool, significantly improved breast cancer screening for female patients in our practice without requiring additional physician or nurse time.[25] Appointment secretaries were trained to use the clinical informatics system PRECARES (PREventive CAre REminder System) to proactively contact patients before they were due for mammography and to schedule it at their convenience. PRECARES was next further developed to include tests that patients with diabetes need every 12 months (HbA1c, LDL, and urine microalbumin), as recommended by most national guidelines,[26] and also USPSTF-recommended adult preventive services. We studied this electronic application in a new, proactive, planned-care, quality improvement pilot initiative to determine whether its use resulted in improvement in the care of patients with diabetes mellitus.

Methods

Practice setting and patient population

Mayo Clinic Rochester is a large, multispecialty, group practice in Rochester, Minnesota. The Division of Primary Care Internal Medicine (PCIM) consists of 38 internists who provide care for 32 000 adult patients from a population of approximately 120 000. Of these primary care patients, 2200 patients have diabetes mellitus. The division is geographically distributed into four sections, each with their dedicated allied health support staff.

Study design and intervention process

A web-based system, PRECARES, was developed for appointment secretaries to test proactive care management of patients with diabetes mellitus as a practice and quality improvement initiative. The study began on 1 January 2006 with identification of eligible patients and ended on 31 March 2007 with collection of the final metrics for analysis. As a practice improvement and quality initiative, the diabetes patients from two PCIM sections who were due or overdue for all their 12-month tests were identified through PRECARES. They were sent a letter advising them to schedule those tests and a follow-up appointment with the primary care physician.

Patients of the other two sections continued to get usual care, which consisted of patients calling for their 12-month tests and visit or their physicians ordering the tests when the patient was seen during a previous appointment. Patients in the PRECARES group were contacted twice, in March 2006 and in June 2006. When a patient called the dedicated appointment secretaries, three tests were ordered on behalf of the physician, and the patient had an appointment with the primary care physician the day after the tests were performed. If the patient was due for any other adult preventive service, as identified by PRECARES (e.g. mammogram), that would also be scheduled. The process and outcome measures for diabetes-specific tests and all preventive services were analysed for both

groups at baseline and on 31 March 2007. This retrospective study was approved by the Mayo Clinic Institutional Review Board.

Usual care

Patients in our practice receive their diabetes care in many different ways. Many undergo tests during an office visit for a general examination or acute care, and they are contacted afterwards by their physician to discuss test results and adjustments to their treatment regimen. Some patients call the office to request a test, in which case the appointment secretaries forward the request to the nurse and physician team. The team reviews the record and sends a message back to the appointment secretaries to schedule the tests and follow-up visit.

Measurements

The evaluation of process and outcome measures was based on a cross-sectional comparison of test completion and diabetes control rates at the end of the study period. The diabetes process measures were HbA1c test completion within six months, LDL evaluation within 12 months, and urine microalbumin test within 12 months. The diabetes outcome measures were HbA1c levels less than 7%, LDL levels less than 100 mg/dL, and urine microalbumin levels less than 30 mg per 24 hours.

Other age- and gender-appropriate preventive service process measures included: pneumococcal immunisation (age, >65 years); bone mineral density test (age, 60–65 years; one test); tetanus–diphtheria immunisation within the past ten years; colorectal cancer screening (age, 50–80 years; faecal occult blood test annually; or flexible sigmoidoscopy every five years; or barium enema every five years; or colonoscopy every ten years; or computed tomographic colonography every five years); influenza immunisation within the past year; lipid screen (age 35–75 years for men and age 45–75 years for women; once every ten years); mammography for women within the past year (age, 40–75 years); and Papanicolaou smears for women within the past three years (age 21–65 years). These data were obtained from the medical record. Demographic information, including age, sex, and date of last primary care visit, was obtained from an administrative database.

Statistical analysis

We performed the analysis on an intention-to-treat basis and compared patients assigned to the intervention group with control patients. We included all patients who met the criteria of being due or overdue for all three 12-month laboratory tests, irrespective of adherence to the intervention. We compared baseline patient characteristics and outcome variables across treatment groups. Categorical variables were compared by using χ^2 or Fisher exact tests, and continuous variables were compared by using t tests or Wilcoxon rank sum tests. We considered 2-sided P values less than 0.05 to be statistically significant. We used SAS version 9.1 (SAS Institute, Inc., Cary, North Carolina) for analyses. We determined the minimal sample size necessary to detect a difference of the size observed using α=0.05 for a 2-sided test.

Results

Demographic information

A total of 48 patients in the intervention group and 75 patients in the control group were due for the three identified diabetes surveillance tests. The difference in numbers of patients between these groups was due to the larger number of primary care physicians in the PCIM sections assigned to the control group. The demographic data of the patient groups is shown in Table 1. Although more male patients were in the intervention group, the difference was not statistically significant (P=0.17). The time since the last visit to a primary care provider also was analysed and showed no significant difference between the groups (P=0.80).

Effect on process and outcome measures for diabetes mellitus

Effects of the quality initiative on process and outcome measures for diabetes mellitus are shown in Table 2. Because of the study inclusion criteria, baseline data for process measures were similar for the two groups (none of the patients had an HbA1c, LDL or urine microalbumin test performed during the appropriate time frame). Twelve of the 48 patients in the intervention group and 18 of the 75 patients in the control group were not in our primary care practice as of 1 April 2007; they may have moved to another geographical location or practice. Thirty-three percent of the intervention patients and 21% of control patients were up-to-date with their HbA1c within the last 6 months (P=0.14). In the intervention group, 14.6% of patients had HbA1c levels less than 7%, and in the control group, 8% of patients had levels less than 7% (P=0.25). A sample size of 362 patients would be required in each group to detect a significant difference of this size with 80% power and α=0.05.

Table 1 Patient data

Characteristic	Control (*n*=75)		Intervention (*n*=48)		*P* value
	n	%	*n*	%	
Sex					0.17
Male	39	52.0	31	64.6	
Age (years)					0.12
<18	1	1.3	0	0	
18–29	0	0	2	4.2	
30–44	3	4.0	6	12.5	
45–59	20	26.7	9	18.8	
60–74	26	34.7	12	25.0	
≥75	25	33.3	19	39.6	
Years since last primary care visit					0.80
<1.00	31	41.3	25	52.1	
1.00–1.99	20	26.7	12	25.0	
2.00–2.99	13	17.3	6	12.5	
3.00–3.99	6	8.0	3	6.3	
≥4.00	5	6.7	2	4.2	

Table 2 Effect of quality initiative on diabetes surveillance and control

	Baseline (31 January 2006)					Post-intervention (31 March 2007)				
	Control (*n*=75)		Intervention (*n*=48)		*P* value	Control (*n*=75)		Intervention (*n*=48)		*P* value
Outcome measure	*n*	%	*n*	%		*n*	%	*n*	%	
Haemoglobin A1c Tested in the past 6 months	0	0	0	0	...	16	21.3	16	33.3	0.14
Level <7%	0	0	0	0	...	6	8.0	7	14.6	0.25
LDL Tested in the past 12 months	0	0	0	0	...	24	32.0	21	43.8	0.19
Level <100 mg/dL	0	0	0	0	...	10	13.3	17	35.4	0.004
Urine microalbumin tested in the past 12 months	0	0	0	0	...	13	17.3	12	25.0	0.30
All measures met	0	0	0	0	...	0	0	1	2.1	0.39

Of patients who had had their LDL levels checked within the past year, 43.8% were in the intervention group and 32% were in the control group (P=0.18). Thirty-five percent of patients in the intervention group had an LDL level of less than 100 mg/dL, whereas 13% of control patients had attained this level (P=0.03). Twenty-five percent of intervention patients were up-to-date on microalbumin testing (tested in the past 12 months), and 17.3% of patients in the control group were up-to-date (P=0.30). A sample size of 445 patients in each group would be necessary to find a difference of this size with 80% power.

Completion rates of adult preventive services

The completion rate (up-to-date status) of all recommended adult preventive services is shown in Table 3. At the end of the study period, more patients in the intervention group were up-to-date on osteoporosis screening, colorectal cancer screening, and influenza vaccination, whereas more patients in the control group were up-to-date on breast cancer screening and cervical cancer screening. However, none of these differences were statistically significant.

Discussion

This quality improvement study shows the value of a clinical informatics system for primary care to provide proactive, population-based care for patients with type 2 diabetes mellitus. Redesign of the care process for patients with diabetes who were due or overdue for the recommended yearly tests resulted in significantly improved lipid control.

The new care model, tested with the intervention group, allocated tasks to the care team members in an economical fashion and allowed all team members to work to their highest level of licensure. Our previous experience showed that physicians and their allied health team members can spend three to five minutes determining which diabetes tests might be due for each patient. These are tasks that can be performed more efficiently by allied health team members using electronic tools and thus have the potential to reduce cost of care for practices.

Improved glycaemic and lipid control in patients with diabetes mellitus leads to improved outcomes and reductions in cost of care.[5] The national average of controlled HbA1c for the population of patients with diabetes is approximately 8%,[7,8,14] which is similar to that of our control group. However, although the difference was not statistically significant, our intervention group had a 1.8-fold higher rate of HbA1c control. This study suggests that a practice redesigned to involve allied health team members and use standardised order sets and electronic tools can improve the care delivery by ensuring timely performance of surveillance tests. Furthermore, care is improved by having appropriate test results available at the time of the follow-up visit.

Clinical inertia on the part of primary care providers has been identified as a barrier to improved care for patients with chronic illness.[6] We believe that the inertia partly is due to fragmentation of the care processes, unco-ordinated care delivery, and failure to use

Table 3 Completion rate of preventive services (up-to-date status)

	Baseline (31 January 2006)					Post-intervention (31 March 2007)				
	Control		Intervention		*P* value	Control		Intervention		*P* value
Service	*n*[a]	%	*n*[a]	%		*n*[a]	%	*n*[a]	%	
Pneumococcal immunisation	19/28	67.9	15/17	88.2	0.16	24/32	75.0	15/17	88.2	0.46
Bone mineral density	5/13	38.5	3/7	42.9	>0.99	6/15	40.0	5/7	71.4	0.36
Tetanus-diphtheria immunisation	36/57	63.2	32/36	88.9	0.006	42/57	73.7	31/36	86.1	0.16
Colorectal cancer screening	18/36	50.0	12/19	63.2	0.35	20/35	57.1	13/19	68.4	0.42
Influenza immunisation	14/48	29.2	17/28	60.7	0.007	19/50	38.0	17/29	58.6	0.08
Lipid screen	37/38	97.4	19/19	100.0	>0.99	37/39	94.9	17/18	94.4	>0.99
Mammography	9/17	52.9	3/5	60.0	>0.99	11/18	61.1	2/6	33.3	0.36
Papanicolaou smear	6/10	60.0	1/5	20.0	0.28	6/8	75.0	2/4	50.0	0.55

[a] The fraction shows the number of tested patients/number of eligible patients.

electronic applications that can improve patient care. The healthcare industry is behind other industries with regard to applying information technology when developing and improving care delivered to patients. We agree with others who believe that information technology, new models of care, and practice redesign are needed to improve the value of care for patients with chronic conditions.[27,28]

Our study had several limitations. First, the study was a controlled cohort analysis; it was not practical to conduct a randomised controlled trial of this intervention in a busy clinical practice. Furthermore, this project was a pilot study that was performed in anticipation of disseminating the intervention to the entire practice. Second, we had relatively small sample sizes for both groups because we studied the PRECARES application for only two months. Despite the small sample size, we were able to show that control of LDL significantly improved for patients in the intervention group. Higher patient enrolment and longer study duration might have enabled us to achieve statistically significant differences in outcomes for control of HbA1c and other process measures for diabetes mellitus.

In March 2007, after an internal review of these results, we began using PRECARES for all patients with diabetes mellitus in our practice (2200 patients). Within three months, the percentage of patients who were due or overdue for their 12-month tests decreased from 15% to 5%. We are still collecting data from this large patient group and will be reporting our findings in the future.

Compared with other Western countries, primary care informatics in the USA has not developed to the point that it enables quality improvement.[29] Regarding healthcare reform in the USA, many experts emphasize the importance of revitalising the country's primary care system to improve quality, increase access, and contain costs.[30] However, US healthcare providers make minimal use of health information technology, especially compared with health systems in other industrialised countries. Currently, only about 17% of US physicians have at least a basic electronic medical record system.[31] Infrastructure investment therefore must address the substantial value of clinical informatics and new models of co-ordinated care to improve the primary care delivered to patients. Thus, it is important for healthcare providers to acquire and use electronic health records and also to have systems that improve the standard of patient care.[31]

Themes emerging at international levels suggest that healthcare systems based on clinical informatics should be applied at the enterprise, practice and individual provider level. Success will require close collaboration between a broad range of stakeholders and will need physician leadership to understand the real value of informatics for improving care processes. Some practices with electronic medical records seem to have legacy systems that have succeeded only in converting paper records into an electronic format without decision support.[31,32] Opportunities exist, even for primary care physicians, to enable clinical decision support by using informatics to maximise the value of health information technology.

In the emerging field of informatics for primary care, physicians should strive to develop clear, internationally acceptable definitions and standards, share experiences of using informatics in practice, define best practices, and highlight gaps between pockets of excellence and real-world practice.[32] This is especially true for treatment of chronic conditions like diabetes mellitus, which is becoming a global epidemic. Without systems that allow cost-effective management, primary care physicians can be overwhelmed. Knowledge sharing by users of different electronic medical record systems in different countries will also provide a greater understanding of how information technology is best used in primary care.[32] Informatics leaders realise this unique opportunity to improve primary care and should promote its role in the national health care reform strategy.[29]

Conclusion

The quality of care for patients with diabetes mellitus can be improved by redesign of primary care practice and use of clinical analytics to proactively identify patients who are in need of care. These new models of care will lead to advances in patient safety. Furthermore, improved management of chronic conditions will reduce complications and expenditure for care.

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CONFLICTS OF INTEREST

None.

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