Diabetes Quality of Care and Outpatient Utilization Associated With Electronic Patient-Provider Messaging: A Cross-Sectional Analysis

LYNNE T. HARRIS1
SEBASTIEN J. HANEUSE, PHD2,3
DIANE P. MARTIN, MA, PHD1
JAMES D. RALSTON, MD, MPH1,2

OBJECTIVE — To test the hypothesis that electronic patient-provider messaging is associated with high care quality for diabetes and lower outpatient utilization.

RESEARCH DESIGN AND METHODS — We conducted a cross-sectional analysis of electronic patient-provider messaging over a 15-month period between 1 January 2004 and 31 March 2005. The study was set at Group Health Cooperative—a consumer-governed, nonprofit health care system that operates in Washington and Idaho. Participants included all patients aged ≥18 years with a diagnosis of diabetes. In addition to usual care, all patients had the option to use electronic messaging to communicate with their care providers. The primary outcome measures were diabetes-related quality-of-care indicators (A1C, blood pressure, and LDL cholesterol) and outpatient visits (primary care, specialty care, and emergency).

RESULTS — Nineteen percent of patients with diabetes used electronic messaging to communicate with their care providers during the study period (n = 2,924) (overall study cohort: 15,427 subjects). In multivariate models, frequent use of electronic messaging was associated with A1C <7% (relative risk [RR] 1.36 [95% CI 1.16–1.58]). Contrary to our hypothesis, frequent use of electronic messaging was also associated with a higher rate of outpatient visits (1.39 [1.26–1.53]).

CONCLUSIONS — Frequent use of electronic secure messaging is associated with better glycemic control and increased outpatient utilization. Electronic patient-provider communication may represent one strategy to meet the health care needs of this unique population. More research is necessary to assess the effect of electronic messaging on care quality and utilization.

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From the 1Department of Health Services, University of Washington School of Public Health and Community Medicine, Seattle, Washington; and the 2Center for Health Studies, Group Health Cooperative, Seattle, Washington; and the 3Department of Biostatistics, University of Washington School of Public Health and Community Medicine, Seattle, Washington.

Corresponding author: Lynne T. Harris, lhowsen@u.washington.edu.

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Table 1—Patient services on the MyGroupHealth Web site

| Level of access               | Registration only | Identity verification |
|-------------------------------|-------------------|-----------------------|
| Healthwise knowledge base     | X                 | X                     |
| Discussion groups             | X                 | X                     |
| Health assessment tools       | X                 | X                     |
| Choose a PCP                   | X                 | X                     |
| Appointment requests          |                   |                       |
| Shared medical record         |                   |                       |
| Pharmacy refills and list of medications |       | X                     |
| Secure messaging to and from health care team |   | X                     |
| Medical test results          |                   | X                     |
| After-visit summaries         |                   | X                     |
| Medical conditions            |                   | X                     |
| List of allergies             |                   | X                     |
| Immunization history          |                   | X                     |

health information with Group Health Cooperative providers but could access discussion groups on several topics. Group Health Cooperative discouraged disclosure of personally identifiable information in the discussion groups. A facilitator was employed to review all content and remove any personally identifiable content. A second, higher level of security provides access to the medical record, secure messaging, and other advanced Web services. Access to this security level required each patient to complete an additional step verifying the patient's identity. At this level of security, patients and providers shared clinical and other personal health information. Patients could obtain identity verification through an online request or in person at a Group Health Cooperative clinic with a driver's license or a passport.

Inclusion criteria and cohort definitions

The study was restricted to diabetic patients aged >18 years who were continuously enrolled in Group Health Cooperative's Integrated Group Practice during the study period. Patients were identified as having diabetes by three or more outpatient ICD-9 diagnoses for diabetes during 2 years before the study period. We divided the study population into several groups, depending on their level of Web service use (Fig. 1). Of the baseline population of adults with diabetes at Group Health Cooperative, 34% completed the process of identity verification to gain access to secure messaging and other advanced services. This group was further divided into two subgroups:

- members who used secure messaging at least once during the study period (secure messaging users)
- members who had obtained identity verification but did not use secure messaging during the study period (identity verified). The identity-verified group subjects were selected as the primary comparison cohort because they were expected to be most similar to the secure messaging users in terms of unmeasured characteristics (Fig. 1).

Measurement of primary outcome variables

Three diabetes-related quality-of-care indicators were selected to assess care quality: A1C <7%, blood pressure ≤130/80 mmHg, and LDL cholesterol <100 mg/dl. Outpatient visits were identified and categorized using Current Procedural Terminology and department codes.

Measurement of secure messaging

Message threads, rather than individual messages, were used to quantify secure messaging activity. A thread was defined as the set of messages related to an original message by successive replies. Threads could be initiated by patients or providers. A prior analysis of patient-provider messaging patterns at Group Health Cooperative has suggested that a message thread is most conceptually similar to a single episode of clinical care. For example, during 2004, 96% of all threads contained 5 or fewer messages, 86% spanned ≤3 calendar days, and 99.7% contained fewer than 10 messages.

Patient population characteristics

Patient age and sex were abstracted from administrative databases. Twelve adjusted diagnostic groups were selected a priori to control for medical comorbidity. ICD-9 data were used to generate a count of complications to control for diabetes severity. Depression severity was modeled as an ordinal variable with four levels (G. Simon, personal communication). A history of depression was de-
Quality of care and electronic messaging

Table 2—Population characteristics

|                          | MyGroupHealth identity verified | Secure messaging users |
|--------------------------|---------------------------------|------------------------|
|                          | Nonverified*                    | 1–3 threads | 4–11 threads | ≥12 threads |
| n                        | 10,153                          | 1,892       | 814          | 218         |
| Male sex                 | 52                              | 46          | 49           | 49          |
| Age (years)              | 64 ± 13                         | 58 ± 12     | 57 ± 12      | 57 ± 11     |
| <35                      | 1.9                             | 3.2         | 3.1          | 4.1         |
| 35–49                    | 12                              | 17          | 24           | 21          |
| 50–64                    | 36                              | 52          | 50           | 53          |
| ≥65                      | 50                              | 28          | 23           | 22          |
| Low neighborhood SES     | 25                              | 20          | 19           | 24          |
| Distance to clinic (miles)| 9.6 ± 69                        | 13 ± 108    | 7.8 ± 9.7    | 7.9 ± 11    |
| Rural                    | 3.0                             | 3.4         | 4.0          | 3.7         |
| Insurance                |                                 |             |              |             |
| Commercial               | 46                              | 68          | 73           | 65          |
| Medicare                 | 52                              | 31          | 26           | 33          |
| Medicaid, Basic Health Plan | 1.9                        | 0.9         | 0.4          | 1.8         |
| Expected resource use    |                                 |             |              |             |
| None or low              | 5.8                             | 3.8         | 2.7          | 0.5         |
| Moderate                 | 48                              | 51          | 46           | 22          |
| High                     | 26                              | 28          | 30           | 38          |
| Very high                | 21                              | 18          | 21           | 39          |
| Depression visits‡       | 0.69 ± 2.7                      | 0.83 ± 4.1  | 1.1 ± 4.3    | 2.5 ± 8.9   |
| Diabetes complications    | 1.5 ± 1.1                       | 1.3 ± 1.1   | 1.3 ± 1.1    | 1.8 ± 1.0   |
| Quarters with any secure messaging | N/A                          | 1.5 ± 0.67  | 3.2 ± 1.0    | 4.4 ± 0.85  |
| Patient’s ratio of secure messaging threads: all encounters | N/A                          | 0.20 ± 0.14 | 0.41 ± 0.17  | 0.54 ± 0.16 |
| PCP ratio of secure messaging threads: all encounters | 0.14 ± 0.07                   | 0.16 ± 0.08 | 0.18 ± 0.09  | 0.19 ± 0.10 |
| PCP male sex             | 72                              | 71          | 68           | 67          |
| Panel size               | 1,408 ± 363                     | 1,403 ± 356 | 1,375 ± 356  | 1,382 ± 351 |
| Tenure with PCP (years)  | 6.2 ± 5.2                       | 6.2 ± 5.2   | 6.1 ± 5.3    | 6.2 ± 5.1   |
| A1C (%)                  | 7.8 ± 1.6                       | 7.6 ± 1.5   | 7.6 ± 1.5    | 7.5 ± 1.6   |
| <7                       | 34                              | 37          | 38           | 45          |
| Blood pressure (mmHg)    | 134/74 ± 20/11                  | 132/75 ± 18/11 | 132/76 ± 18/11 | 132/75 ± 19/11 |
| <130/80                  | 33                              | 36          | 34           | 36          |
| LDL cholesterol (mg/dl)  | 96 ± 35                         | 95 ± 35     | 94 ± 36      | 93 ± 34     |
| <100                     | 80                              | 81          | 81           | 83          |
| Outpatient visits‡       | 9.5 ± 14                        | 9.7 ± 14    | 12 ± 15      | 18 ± 20     |
| Primary care             | 49                              | 47          | 45           | 42          |
| Specialty care           | 47                              | 51          | 53           | 55          |
| Emergency                | 4.6                             | 3.1         | 3.2          | 4.1         |

Data are % or means ± SD. *Patients with no MyGroupHealth Web site registration or only basic username/password registration. †Patients who registered to use the MyGroupHealth Web site and completed secondary identity verification but never used secure messaging. ‡Annualized visits. SES, socioeconomic status.

Defined by three or more outpatient visits with an ICD-9 diagnosis of depression in the year before the study. Moderate depression was defined by any diagnosis of depression by a psychiatrist or other mental health specialist, and severe depression was defined by any inpatient mental health admission. Insurance was grouped into the following three categories: commercial, Medicare, or Medicaid. Members with Medicaid insurance were grouped with members in Washington State’s Basic Health Plan—an insurance program for low-income individuals not qualifying for Medicaid. Primary care provider (PCP) participation in secure messaging was measured as a percent of total outpatient encounters. Neighborhood-level race, income, and educational attainment were abstracted from U.S. Census data. High neighborhood racial diversity was defined as a nonwhite population of over 20%. Low neighborhood socioeconomic status was defined as a neighborhood where at least 20% of the population earned <20,000 USD per year or at least 25% of adults aged >25 years had less than a high-school education (11). Census data were further used to determine rural or urban residence, and home address records were used to calculate the distance from home to clinic.

PCP characteristics

Provider’s sex and specialty, quintile rank of age, the proportion of secure messaging threads that were provider initiated, and the average provider response time were abstracted from administrative databases.
Statistical analysis

Multivariable regression models were used to examine the association between secure messaging use and care quality. A second set of models was generated to examine the association between secure messaging use and the number of outpatient visits. The patient was the unit of analysis for all regression models, with clustering by PCP. Log-linear models were used to estimate relative risks (RRs) or rate ratios. Models were adjusted for age, sex, overall medical comorbidity, diabetes severity, depression severity, insurance, and PCPs age, sex, and participation in secure messaging. To ensure a flexible specification and minimize residual confounding, age was modeled using linear splines. Neighborhood-level racial/ethnic and socioeconomic status measures were not significant in preliminary models and were dropped from the final models. Generalized estimating equations were used to estimate regression coefficients (12), and the Huber-White robust sandwich estimator was used for variance estimates (13). The Wald tests were used to assess the significance of explanatory variables, using two-sided $P$ values evaluated at the 0.05 significance level.

RESULTS — Thirty-four percent of the study cohort completed the process of identity verification for use of advanced Web services including secure messaging ($n = 5,274$) (overall study cohort included 15,427 subjects). Of the patients who obtained identity verification, 55\% went on to use secure messaging ($n = 2,924$). Secure messaging users participated in an average of 5.3 threads, consisting of 11.8 individual messages. Altogether, 86.9\% of threads were patient initiated.

The mean age of the secure messaging cohort was 58 years, whereas the mean age of the nonmessaging subgroups was 63 years (Table 2). Among the subgroup with at least 12 secure messaging threads per year, 77\% had high or very high expected resource use compared with 44\% of the identity-verified cohort.

Sixty-four percent of PCPs with high secure messaging use were female compared with 37\% of PCPs with low secure messaging use (Table 3). Ten percent of PCPs with high secure messaging use and 32\% of PCPs with low secure messaging use had panels of over 2,000 patients.

Unadjusted RRs are presented in Table 4 (Model A). In multivariable models, the rate of A1C <7\% was 36\% higher in patients with the highest rate of secure messaging use (≥12 threads per year) compared with that in the nonmessaging identity-verified comparison cohort (RR 1.36 [95\% CI 1.16–1.58]) (Table 4). In contrast, secure messaging use was not associated with control of blood pressure <130/80 mmHg. There was a small but statistically significant association between secure messaging and LDL cholesterol <100 mg/dl. For all three quality measures, the nonmessaging identity-verified cohort had slightly better outcomes than the nonmessaging nonverified cohort.

The primary care visit rate was 32\% higher among patients with high use of secure messaging compared with that in the nonmessaging comparison cohort (RR 1.32 [95\% CI 1.19–1.45]) (Table 4). This translates to approximately three to four additional outpatient office visits, given a baseline visit rate of nine visits per year. High secure messaging users also had more outpatient specialty visits (1.43 [1.25–1.64]) (Table 4) and emergency care visits (1.66 [1.23–2.26]) (Table 4) than the nonmessaging comparison cohort.

CONCLUSIONS

Secure messaging and glycemic control

In this cross-sectional study, patients who used more secure messaging had better glycemic control. Secure messaging may have enabled better glycemic control by filling unmet needs for care. Care providers may have used secure messaging to recommend medication adjustments, thereby optimizing treatment regimens more quickly. Medication intensification has previously been found to be the most significant predictor of variation in A1C (14). By increasing the frequency of contact, secure messaging might also strengthen continuity of care, which has also been associated with improved glycemic control (15).

As with all observational studies, unmeasured differences between users and nonusers of secure messaging may also explain our results. Users of secure messaging may have had higher health literacy, education, or other characteristics that are also found among individuals with better glycemic control. Patients who engage in secure messaging may also be more engaged in self-care behaviors that promote better glycemic control.

Finally, it is possible that use of advanced Web services other than secure messaging, which included prescription refills, appointment scheduling, and medical record access, may explain some of these results. Among patients who did not use secure messaging, the cohort who had access to advanced Web services exhibited slightly better control of A1C, blood pressure, and LDL cholesterol than the cohort without access.
Secure messaging and outpatient visit rates

Contrary to our hypothesis, we found a positive association between secure messaging use and the number of outpatient visits. Two prior longitudinal studies of physicians have found electronic messaging systems to be associated with a reduction in outpatient visit rates (4,5). These studies suggest that electronic consultations may substitute for traditional in-person office visits. Our results may differ from these studies because of our focus on diabetes. Patients with diabetes who use secure messaging may be more proactive with care providers both online and in person and may use secure messaging as a complement to care rather than as a substitute. Secure messaging use may also raise unmet needs in this population that require further engagement either in person or through secure messaging.

Strengths and weaknesses of the study

This is the one of the first studies to examine the association among electronic messaging and outpatient visit rates.
patient-provider messaging, diabetes-related health outcomes, and outpatient utilization in a large health care delivery system. Although several important studies have been published in this area over the past 5 years, most are limited by small sample sizes. In contrast, a key strength of our study is its setting: a large nonprofit health care system that serves ~300,000 members. Limitations include the cross-sectional design of the study, the short duration of exposure to secure messaging, and potential self-selection bias. Secure messaging users may have differed from nonusers by unmeasured factors such as self-efficacy, attitudes toward medical care, race, socioeconomic status, and health literacy. Given the cross-sectional design of this study, it is impossible to conclude that electronic messaging caused the outcomes that we observed. Randomized controlled trials or longitudinal analyses will be required to assess the causal relationship among secure messaging and utilization, care quality, and health outcomes.

Unanswered questions and future research

As physicians and health care organizations consider how and when to support electronic communication with patients, we must understand how this new care environment differs from traditional in-person care. Secure messaging may serve as an important part of care for patients with diabetes and an opportunity to support them in self-management outside of routine visits. Our findings suggest that patients with diabetes who are frequent users of electronic patient-provider messaging systems may represent a unique patient population, characterized by better glycemic control and a greater use of outpatient visits.

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