Final Grant Report

Title: SM and Chronic Illness Care
Principal Investigator: James D. Ralston, MD MPH
Co-Investigators: Gregory Simon, MD MPH
Carolyn Rutter, PhD
Harold Goldberg, MD
Other team members:
David Carrell, PhD
Julia Hecht, PhD
Lynda Tyll, RN MS
Organization: Center for Health Studies, Group Health Cooperative
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Abstract:
Purpose: To conduct a retrospective analysis of a large and uniform patient secure messaging (SM) application at Group Health Cooperative.

Scope: Examine predictors of SM use among the general enrollee population and enrollee populations with diabetes, depression, and congestive heart failure. Examine the association between SM use and glycemic, lipid, and blood pressure control among enrollees with diabetes.

Methods: Retrospective cohort of health plan enrollees over the age of 18 years who were continuously enrolled from October of 2003 through April of 2005 at Group Health, a mixed-model health care system based in Seattle, Washington.

Results: Among all eligible enrollees, 14% (29,196) exchanged one or more SM with a primary or specialty care provider between January 1st, 2004 and March 31st of 2005. Higher SM use by enrollees was independently associated female gender (odds ratio [OR], 1.14; 95% confidence interval [CI], 1.09-1.19), greater anticipated clinical need (OR, 3.46; 95% CI, 3.11-3.85, comparing high or very high to very low anticipated clinical need), and the primary care provider's use of SM with other patients (OR, 1.94; 95% CI, 1.70-2.22, comparing 20-50% vs.≤10% encounters through SM). Less SM use was associated with enrollee age over 65 years (OR, 0.63; CI, 0.58-0.67) and Medicaid insurance vs. private insurance (OR, 0.80; 95% CI, 0.67-0.95). We found limited differences in characteristics associated with SM use in the general enrollee population compared to those with depression, diabetes, and congestive heart failure. In adjusted analyses of enrollees with diabetes, SM use was positively associated with having a low density lipoprotein < 130 mg/dL (OR, 1.21; 95% CI, 1.04-1.41) and a hemoglobin A1c < 7% (OR, 1.38; 95% CI, 1.25-1.52), but not a blood pressure < 130/80 mm Hg (OR, 1.10; 95% CI, 0.97-1.25).

Conclusion: Enrollees who used SM were largely the same as those that use other health care services, with the exceptions of less SM use among enrollees over the age of 65 years and those having Medicaid insurance. SM use was associated with better glycemic and blood pressure control in patients with diabetes. These findings support further use and investigation of secure patient-provider messaging in patients with chronic conditions.

Key Words: electronic patient-provider communication, chronic illness care, diabetes, quality of care

Purpose:
The overall goal of this project was to evaluate the potential role of secure electronic messaging (SM) between patients with chronic medical conditions and their health care providers.

We had two specific and sequential aims.

1. Describe the characteristics of patients with diabetes, congestive heart failure, and depression who use and do not use SM.
2. Evaluate the association between SM use and the quality of diabetes care including the measures of hemoglobin A1c, low density lipoprotein (LDL) and blood pressure (BP).

For the first aim, we started with a description of online SM among the general patient population. We then compared this to the use of SM among patients with one or more of the three chronic medical conditions listed above. Last, we evaluated the potential association of SM use with more effective care of patients with diabetes. For this last analysis, we changed our selection of quality measures from our original proposal (hemoglobin A1c, retinopathy screening, and foot screening) in order to better represent the American Diabetes Association's key management goals of lipid, blood pressure, and glycemic control. We conducted our study through a retrospective analysis of a large and uniform SM application at Group Health Cooperative (Group Health) in Washington and Idaho. The results of these aims should help inform the development and evaluation of future online health services for patients with chronic medical conditions.

Scope

Background

Secure electronic messaging between patients with chronic medical conditions and their health care providers has the potential to fill an important gap in patient care. This form of communication promotes a shift away from care that is focused on periodic acute-care office visits toward more continuous care and connection between patients and providers. Patients with chronic medical conditions may well shift toward a balance of online communications with providers, phone visits, and clinic visits.

This study was aimed at our limited understanding of 1) the factors associated with access and use of electronic patient-provider messaging among patients with chronic medical conditions; 2) the pattern of electronic patient-provider messaging among patients with chronic medical conditions; and 3) the impact on the quality of care from electronic patient-provider messaging in patients with diabetes. This study is a first step in understanding the role of secure electronic communications in a real world setting of a large, integrated health care system

Context

Web-based communications offer the potential to facilitate organized and secure patient-provider communication. Integrated online health services for patients, known as patient Web portals, are growing in the United States. Currently, Partners Healthcare, Kaiser Permanente, Geisinger Health System, Palo Alto Medical Foundation, Beth Israel/Deaconess, and Group Health are among the institutions that provide these Web portals for their patients. Patient-provider secure messaging is one of the key services provided by patient Web portals. Other services provided by Web portals include access to portions of the electronic medical record, refill requests, appointment requests, and patient education materials.

Patient-provider SM services are best understood in the context of the other online services available to patients and the overall aims of the supporting health care organization. Group Health's patient Web portal, MyGroupHealth (MyGH), was launched in 2000 with the purpose of creating "a personalized Web experience that provides unparalleled access" for Group Health members.[1] As of August 2003, MyGroupHealth was linked with Group Health's comprehensive clinical information system (CIS). This link allows enrollees to: 1) exchange electronic messages with their entire health care team, including primary and specialist physicians; 2) access in real time their electronic medical record (EMR), including laboratory studies, problem lists, medication lists, allergy history, and immunization history; 3) obtain after-visit summaries with hyperlinks to the Healthwise® knowledge base; 4) obtain refills on medications with free shipping to patients' homes; 5) schedule office appointments with providers online; and 6) access health education information that is tailored and linked to their specific health conditions. Patient access to the EMR is provided through a direct link to EpicCare™, Group Health's CIS from Epic Systems Corporation of Madison, WI. All Group Health providers at Group Health clinics use the EpicCare CIS.

Table 1: Patient Services on MyGroupHealth Web Portal

	Level of Access	
Service	Basic Registration Only[1]	ID Verification[2]
Healthwise® Knowledgebase	X	X
Discussion groups	X	X
Health assessment tools	X	X
Choose a primary care provider	X	X
Appointment requests		X
Shared medical record		
Pharmacy refills and List of Medications		X
SM 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

[1]Basic Registration only: enrollees enter identification number and self-select a password.

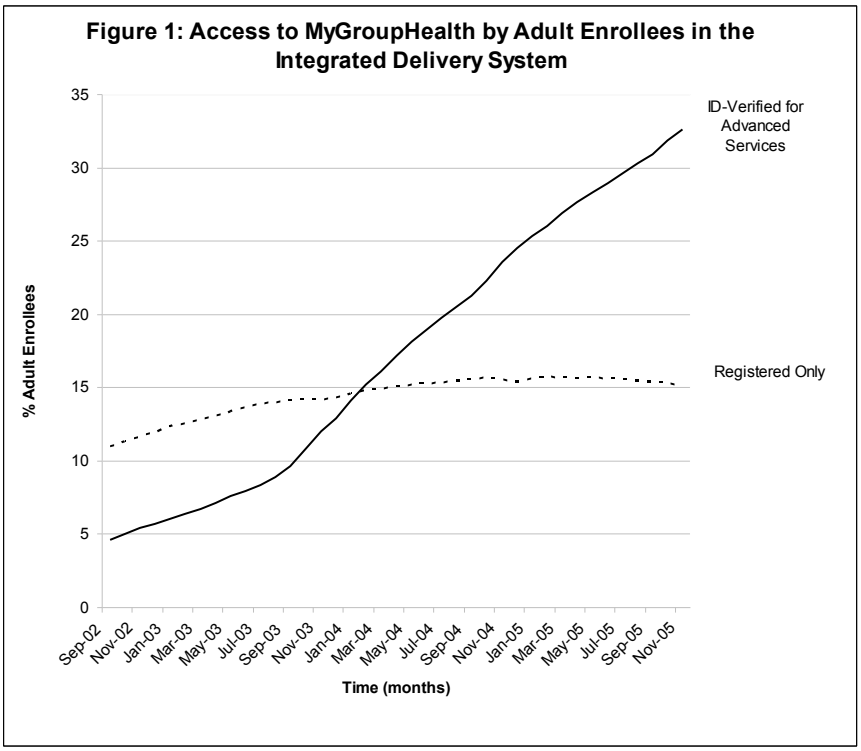
[2]ID Verification: enrollees obtain password by presenting identification at Group Health clinic or requesting one mailed to home address

Table 1 shows the portal services available on the MyGroupHealth patient Web portal. For access to the portal, patients initially register for basic services by entering their enrollee number on the Group Health Web site (**www.ghc.org**) and then set a self-selected password. For a password to access the shared medical record and patient-provider electronic messaging, enrollees must go through the additional step of identification verification (ID verification); enrollees can obtain this password by either presenting identification at a Group Health clinic or by requesting a password be mailed to the home address. As of May 2006, 36% of adult enrollees receiving care in the Integrated Group Practice had completed ID verification (total ID-verified = 114,465).

Figure 1 shows the cumulative uptake of basic registration only and of ID verification. In January 2004, the number of enrollees ID-verified for access to the shared record began to exceed the number registered for basic services only. As of May 2005, 113,932 enrollees were ID-verified for access to their shared online medical record and patient-provider communication; this accounts for 36% of enrollees who receive care in Group Health's integrated delivery system. There is still no visible plateau of ID verification among enrollees.

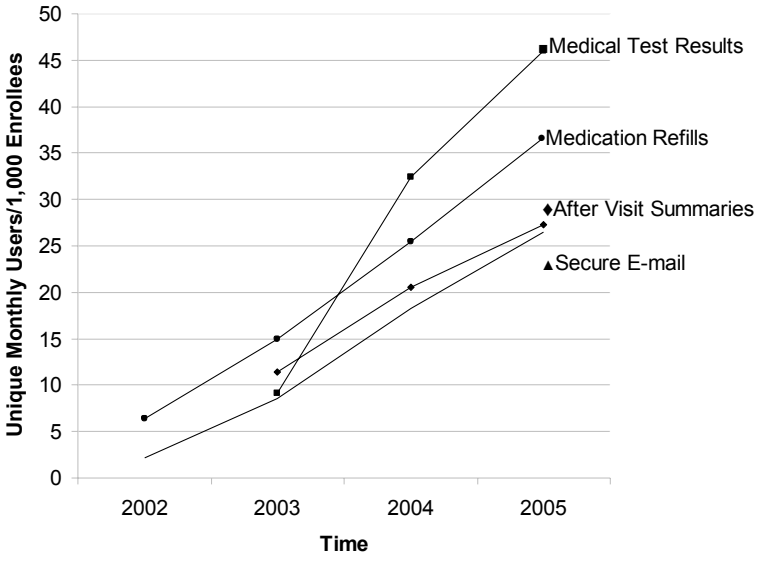
All administrative functions on the MyGH portal are performed in a privacy-aware environment; only those with a legitimate "need to know" have access to the content of patient messages. Secure messages are included in the monitoring of physician productivity as patient encounters alongside

Figure 1: Access to MyGroupHealth by Adult Enrollees in the Integrated Delivery System



in-person and telephone visits and used by the Medical Group in maintaining and supporting performance goals. As of December 2005, unique monthly user rates per 1,000 enrollees were the highest for review of medical test results (46), medication refills (37), patient-provider clinical messaging (27), and after-visit summaries (27); medical condition review (20), appointment requests (10), immunization review (10), and allergy review (6) were less commonly used. Satisfaction with the portal was also highest for medical test results, refills, and secure electronic messaging with providers. **Figure 2** shows the monthly unique users for the four most commonly used portions of the shared record over time. These four services are likely to be most critical for those patients managing multiple chronic conditions where provider communication and access to personal health information are necessary for good self-management.

Figure 2: Most Commonly Used Services of Shared Electronic Record



Secure Clinical Messaging between patients and providers through MyGroupHealth

Patients and providers can initiate messages to one another. Every patient SM interchange is triaged by support staff and automatically placed in the patient's electronic medical record. Secure messages are viewable by all clinicians involved in a patient's care. Response time is tracked every day by administrative staff. If physicians or health care teams are noted to have outstanding messages (longer than one business day old, without a response to the patient), they are contacted and offered assistance in meeting patient expectations. Providers and disease management teams are otherwise free to incorporate SM and other portal functions into care processes as they see fit within each patient-provider relationship.

Setting

This study was conducted at Group Health, an integrated health care system with 417,386 members in Washington and North Idaho. The participants were restricted to members enrolled at group/staff model Group Health owned and operated clinics. As of January 1st, 2003, Group Health membership included 59,321 Medicare members, 30,063 Medicaid members, and 23,334 covered by the Basic Health Plan (a state-supported insurance program for low-income families).

The Group Health population is generally similar to that in the surrounding area. However, the Group Health population is somewhat older. Group Health's population is also somewhat more highly educated than the Metropolitan Statistical Area (MSA), which is to be expected for an organization whose members are mainly enrolled through their job-related insurance. Group Health has a higher African American population (4.3%) than the surrounding MSA (3.2%), but less when compared to the U.S. population (12.3%). The Group Health population is comparable to those that belong to other large managed care organizations. Internet use is listed for specific demographic groups in the Pacific Northwest and U.S. population. Approximately 84% of people with Web access also have an e-mail address.[2]

Participants

The study sample included patients over 18 years of age who were continuously enrolled in Group Health for 12 months prior to the implementation of SM. Participants also had a primary care provider (PCP) in Group Health's integrated delivery system for all 15 months of the study (1/1/2004 to 3/31/2005). The study focused on four patient populations including: 1) the general patient population meeting enrollment criteria; and 2) a subsample with depression; 3) a subsample with diabetes; and 4) a subsample with congestive heart failure (CHF). Within each of these four groups we identified those patients who used and did not use SM with one or more of their health care providers. Data was collected on patients in the study beginning January 1st, 2004 and ending March 31st, 2005. Enrollees were counted as SM users if they had one or more messages during this time period.

We categorized a patient into the depression, diabetes, and CHF groups if 3 or more outpatient diagnoses for the condition were made in the two years prior to the start of the study.

Methods

Study Design

The study design was a retrospective analysis focusing on the four groups of patients previously described.

Aim 1: Characteristics of SM Users and Nonusers

For each of the four groups of SM users, we used two comparison groups of SM non-users.

- Patients who have registered for MyGroupHealth (MyGH) advanced online services but have not used SM to communicate with their health care provider.
- Patients who have neither registered for MyGH advanced online services nor used SM.

Each of these comparison groups provided a different opportunity to compare users and non-users of SM. Patients who have registered for the MyGH advanced services have Internet access and have shown both interest and capability in using online health services. These online patients may have characteristics that are more similar to users of SM than patients who have not accessed Group Health's online services. To increase power, we used data from all available MyGH enrollees with registration for advanced online services who were not SM users.

We used Anderson and Aday's Behavioral Model of Healthcare Access to help inform the approach to and selection of variables potentially associated with SM use.[43] Hypotheses were based on prior studies suggesting patient and provider characteristics associated with internet use, healthcare utilization and patient-provider electronic communication.[3, 4 5-9] We hypothesized that secure messaging use would be positively associated with the following:

- Age over 65 years
- Female gender
- Higher neighborhood socioeconomic status
- Distance from home to clinic > 17 miles
- Rural location
- Higher anticipated clinical need
- Medicaid vs. private insurance
- Medicare vs. private insurance
- Higher PCP SM use with other patients
- Shorter PCP response time to patient SM

Aim 2: SM Use and Medical Care in Patients with Diabetes

We compared patients with diabetes who use SM to patients with diabetes who do not use SM, but who have registered for MyGroupHealth advanced online services. Between these groups, we compared the % of patients reaching the Group Health targets for blood pressure, LDL, and hemoglobin A1c. We performed both unadjusted analyses as well as adjusted analyses controlling for factors associated with SM use, as identified in Aim 1. We hypothesized that SM use would be positively associated with the following Group Health management goals for diabetes:

- LDL <130 mg/dL
- Hemoglobin A1c < 7%
- Blood pressure ≤ 130/80 mm Hg

Statistical Analysis

Descriptive analyses were carried out separately within each of the four patient groups.

We then used logistic regression analyses to model the probability of being an SM user as a function of patient and primary care provider covariates.[49] A Generalized Estimating Equation approach was used to estimate patient-level covariates while adjusting for physician level clustering.[54; 55] Models were fit using SAS statistical software.[58]

Power and Sample Size

Power and precision estimates were based on our initial estimation of the sample sizes in our four patient populations. Our initial estimates of SM use, however, were lower than our actual sample sizes due to the rapid uptake of secure messaging between the time of grant submission and the time of the analysis. For instance, we estimated in our grant application that we would have 430 patients with depression who used SM, but at the time of our study we found 3,185 patients with depression who used SM and met enrollment criteria. The power calculations presented below are based on our initial estimates of SM use in our four patient populations and are, therefore, conservative power estimates.

Power calculations focused on comparisons between SM users and MyGH registrants. Because little was known about SM use, power calculations were based on simple assumptions. For between-group comparisons of means, we estimated the width of 95% confidence intervals for estimated mean differences derived assuming a normal distribution with common variance. Power for tests of difference in proportions were based on a 2-sided chi-square test for differences in proportions with a 0.05 type I error.

Aim 1: For continuous measures, 95% confidence intervals for the estimated difference between SM and non-SM users were $\pm 0.10\sigma$ for depressed patients, $\pm 0.09\sigma$ for diabetic patients, $\pm 0.19\sigma$ for CHF patients, and $\pm 0.03\sigma$ for patients with no chronic illnesses. For dichotomous outcomes we conservatively assumed that 50% of the SM group had the outcome. In this case we had over 80% power to detect an 8 percentage point difference among depressed patients (i.e., 42% or 58%); a 7 point difference in diabetics; a 14 point difference in CHF patients; and a 3 point difference in patients without chronic illness. Power for logistic regression models that adjust for clustering depended on the degree of correlation within providers

Aim 2: Among diabetic patients at Group Health, the overall rate of biennial HbA1c tests was 89%.[39] We assumed that the rates of meeting the target for this outcome, and that of LDL and blood pressure, in the not-SM group were equal to the rates in the overall Group Health population. Based on a chi-square test for differences in proportions, we had at least 80% power to detect the following differences: Biennial HbA1c tests: 89% in not-SM group versus $\leq 84\%$ or $\geq 93\%$ in the SM group. Power for logistic regression models depended on both the degree of confounding and the amount of within-physician clustering.

Data Sources/Collection

We collected all data from automated data sources at Group Health. The SM interface employs Epic Systems Corporation's MyChart® software. Our raw data consists of messaging metadata—all message attributes except body text—maintained by Epic's Clarity® system deployed on a Microsoft SQL Server® 2000 database.

Measures

Secure Messaging: We used the **SM thread** as the unit of analysis for SM activity. We chose this metric based on taxonomy of messaging activity developed through an understanding of the messaging application and its use during the 2004 calendar year.

Our taxonomy involves several interrelated components of electronic text exchange between patients and providers. Like face-to-face verbal conversations about health concerns, electronic medical advice requests are "encounters" carried out through a series of information exchanges between patient and provider. The basic unit of such communication is the **message**. A set of messages related to an original message by successive replies (by one then the other correspondent, in turn) is a **strand**. Conceptually, a strand is the electronic equivalent of verbal conversations between two individuals about a discrete substantive issue. When either correspondent replies more than once to a message a **parallel strand** is initiated, which may be further **developed** by successive replies. A single-message strand without further reply is considered **undeveloped**. The set of all strands descending from an original message (which was not itself a reply) is a **thread**. Threads may contain a single strand or multiple strands. Metadata establish the **electronic association** between messages and strands within a thread. We distinguish **electronic association** from **substantive coherence**, which can only be established through content analysis of threads.

We then applied this taxonomy to the messaging activity of our study population during the 2004 calendar year in order to determine appropriate SM metrics for the study. In 2004, 23,470 patients exchanged 271,569 electronic messages comprising 104,472 distinct threads with 490 providers. Most patients (93%) corresponded with one or two providers (range: 1-9). Half of all messages were from patients. Median messages per patient

in 2004 was 5 (IQR: 2-10, range: 1-356); median threads per patient was 2 (IQR: 1-4, range: 1-130). 96% of threads contained 5 or fewer messages, and only 0.3% contained >10 messages (range: 1-69). Most threads (86%) spanned 3 or fewer calendar days (range: 1-174); 1.5% (1,588) of threads spanned more than 14 calendar (10 business) days. 6% of threads (1,420) had multiple developed strands. To estimate an upper limit to the number of threads that may address more than one *substantive* health issue, we counted all threads that had 1) any developed parallel threads, 2) >10 messages, or 3) a duration >14 days. There were 2,829 such threads, representing 2.7% of all threads

In our setting, the electronic thread appears to be a reasonable approximation of a single episode of health-related communication. We acknowledge the possibility of undercounting the number of substantive health concerns addressed in a message thread. As messaging adoption and messaging interfaces evolve, the assumptions underlying any messaging measurement approach should be reexamined and tested.

Since the mean number of threads per patient during 2004 was two, we chose a bivariate categorization of messaging activity (any messaging vs no messaging) for this study.

Variables Potentially Associated with SM Use. Anderson's Behavioral Model of Health Services Access was used to help inform the approach to and selection of variables potentially associated with SM use.[43] **(figure 2)** This model has been developed over the past 25 years and is grouped around four dynamic and interrelated domains (Figure 2). These include 1) the *environment*, which encompasses characteristics of the health care system as well as the external environment (physical, political and economic factors); 2) *population characteristics,* which include predisposing factors (e.g. language, disabilities), enabling factors (e.g. social relationships, insurance status), and need for service; 3) *behavior,* which includes personal health practices and the use of health services; and 4) *outcomes,* which includes perceived health status, evaluated health status, and consumer satisfaction. Although this model has not been tested in access to online health services, it provided a valuable starting point for identifying and structuring factors that may be related to this particular type of health care access. Variables were further selected based on their demonstrated association with either health care utilization or electronic communications between patients and providers.[3, 4 5-9]

Population Characteristics. Predisposing characteristics included standard demographic data such as age and gender. Socioeconomic status was derived from patient Zip Code in combination with SES indicators from the 2000 Census. Distance from the primary medical center was calculated using each patient's home address.

Enabling characteristics included several health status and clinical variables for patients. Overall comorbidity was assessed with Resource Utilization Bands (RUB) (based on the Adjusted Clinical Group case-mix system).[10-12] For each chronic disease population, we assessed disease-specific severity. For diabetes, we used the count of diabetes complications based on a patient's diagnostic, laboratory, and visit data. Depression severity was assessed as an ordinal variable using the following categories: any history of inpatient mental health care, any history of outpatient psychiatric care, any history of other specialty mental health care, or primary care of depression only. Severity of CHF was determined by number of hospitalizations for CHF. Types of insurance included the commercial plan, Medicare, and Medicaid.

Environment-Health Care System Variables. Primary care provider variables included physician age and years with Group Health and high versus low use of SM with other patients. In multivariate analyses, an individual physician variable was used to control for potential clustering within physician practices. We examined the time it takes for physicians to respond to a patient secure message.

Environment- External Enviroment. The location of each participant's community was determined to be rural or urban according to the United States Census Bureau's definition of Metropolitan Statistical Areas. Distance to clinic was based on a reasonable driving distance for primary care access of less than 20 miles (approximately 30 minutes driving time). We estimated this driving distance using as the crow flies miles and took into account the curvature of the earth. Driving distance is about 20% greater than as the crow flies (16.67 miles for estimate of as the crow flies miles equivalent of 20 miles driving distance), though it varies greatly depending on the terrain (http://www.atlasquest.com/aboutlb/faq/aq.html, accessed 02/07/06).

Quality Measures for Medical Care of Diabetes. We collected data on whether patients with diabetes received hemoglobin A1c testing, fasting lipid profiles, and blood pressure recordings. We evaluated whether each participant met the Group Health standard of care for the Hemoglobin A1c (< 7%), blood pressure (<= 130/80 mm Hg) and LDL (<130 mg/dL). These measures are largely concordant with the American Diabetes

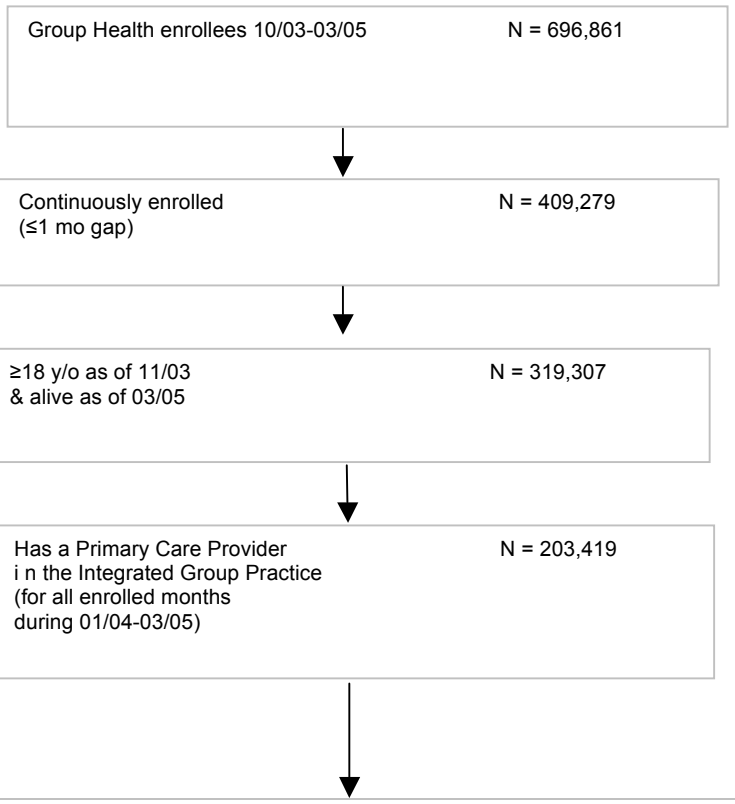
Association standards with the exception of LDL where the ADA has a lower target of < 100 mg/dL. During the study period, Group Health had an LDL target below 100 mg/dL only for patients with diabetes who have concurrent atherosclerotic cardiovascular disease. We were limited in the completeness of the blood pressure data due to a concurrent rollout of the EpicCare CIS during the study period; we were only able to capture blood pressures from those participants who visited clinics who had EpicCare installed.

Results

Principal Findings

Figure 3 shows the study flow and the final number of participants broken down by chronic condition and whether SM users or nonusers (ID-verified and Not ID-verified). During the study period, SM use varied across these groups: general population (14%), depression population (25%), diabetes population (19%), and CHF population (12%).

Figure 3: eHealth Study Population Summary



Secure Messaging Users and Non-users				
			No SM Use	
Populations	Total	SM Use	ID-Verified	Not ID-Verified
Total Population	203,419	29,196	30,795	143,428
Depression†	12,512	3,185	2,009	7,318
Diabetes†	15,427	2,924	2,350	10,153
CHF†	2,989	362	364	2,263

SM-secure messaging; MyGH--MyGroupHealth online services; CHF-- congestive heart failure

‡ SM usage and MyGH registration and/or verification data are as of 4/1/2005.
* These 7954 SM users are 82% of all Group Health SM (MAR) users *ever* (through 08/05).
† These categories are not mutually exclusive, so will not equal the Total Population when summed.

Aim 1

Predictors of SM use by patients in the general population. In the general population of enrollees, our hypotheses of predictors of SM use were confirmed in adjusted analyses for the following:

- Age over 65 years
- Female gender
- Higher anticipated clinical need
- Medicaid vs. private insurance
- Medicare vs. private insurance
- Higher PCP SM use with other patients

In the general population of enrollees, our hypotheses were **not** confirmed for the following:

- Higher neighborhood socioeconomic status
- Distance from home to clinic > 17 miles
- Rural location
- Shorter PCP response time to patient SM

Table 2 shows the unadjusted comparison of SM users to the two comparison groups.

Table 2: Secure Messaging Users and Non-users

	SM Users			SM Non-users				
Characteristics				ID-Verified			Not ID-Verified	
	(n =	*29196)*		*(n =*	*30795)*		*(n =*	*143428)*
Age, mean (SD), y	51	(14)		51	(15)		51	(18)
Male sex, % (No.)	38	(10763)		43	(12923)		46	(63133)
Low Neighborhood SES, % (No.)	6	(1644)		6	(1648)		8	(11714)
Rural location, % (No.)	3	(691)		2	(699)		2	(3374)
Distance from patient's home to clinic ≥ 17 miles % (No.)	7	(2106)		7	(2079)		8	(10441)
Moderate or greater expected clinical need % (No.)	84	(23706)		70	(20859)		61	(84711)
Tenure with PCP, mean (SD), y	5.5	(5.0)		5.4	(5.0)		5.2	(4.8)
Tenure with GHC, mean (SD), y	11.8	(5.6)		11.7	(5.6)		11.1	(5.8)
Insurance								
Commercial, % (No)	82	(23023)		78	(23234)		73	(100691)
Medicare, % (No.)	17	(4894)		20	(6066)		24	(33724)
Medicaid, % (No.)	1	(328)		1	(419)		3	(3474)

Table 3 describes the providers patients messaged with during the study period. Key points from this table include:

- PCPs were the highest users of SM with patients.
- 100% of Group Health PCPs exchanged one or more messages with patients during the study period.
- Several types of providers used SM with patients, including both surgical and medical specialists.

Table 3: Patient Messaging Activity and Outpatient Encounters by Provider Type

	Practitioners			Encounters		
	Total	Messaging		Outpatient Total	Messaging Total	% through Messaging
Characteristics	N	(%)		N	N	(%)
Providers, Total	868	(88)		1058182	109991	(9)
Primary Care Provider	203	(100)		457189	81085	(15)
Specialty Care Provider, Total	359	(89)		375462	18919	(4)
Medical Specialty	228	(89)		257784	13223	(4)
Surgical Specialty	131	(89)		117678	5696	(4)
Physical/Occupational Therapist	90	(78)		91788	780	(0)
Social Worker	46	(78)		24347	288	(1)

Table 4 shows the gender and messaging response time of PCPs with < 20% and ≥ 20% of total outpatient encounters through secure messaging. % encounters is defined with a numerator of total secure messaging threads and denominator of total secure messaging threads plus total outpatient in-person encounters.

Table 4: Primary Care Provider Characteristics

	< 20% Messaging Encounters		≥20% Messaging Encounters	
	(n = 153)		*(n = 50)*	
Male sex, % (No.)	61	(93)	36	(18)
Messaging response time, mean (SD), hours	8.8	(5.3)	6.5	(3.2)

Table 5 shows the adjusted analysis of the same population and variables. For female gender and anticipated clinical need (a correlate of comorbidity), the comparison groups had nearly the same results. For participants with an age over 65 years, the odds of SM was even lower (OR 0.35) in the group without advanced MyGH registration compared to those with advanced registration (OR 0.63). SM use comparison groups had nearly similar results. Participants on Medicaid showed similar pattern of lower odds when using the comparison group without advanced MyGH registration (OR 0.43) compared to those with advanced registration (OR 0.80).

Table 5: Adjusted analysis showing odds ratio of secure messaging use to non-use

	Comparison Group Not Messaging								
	ID Verified					Not ID Verified			
Characteristics	OR	95% CI		p		OR	95% CI		p
Age, years									
18-35	0.93	(0.88 ,	0.99)	0.03		0.78	(0.73 ,	0.82)	0.00
36-50	1.00					1.00			
51-65	1.03	(0.98 ,	1.08)	0.19		1.14	(1.10 ,	1.19)	0.00
>65	0.63	(0.58 ,	0.67)	0.00		0.35	(0.32 ,	0.37)	0.00
Female	1.14	(1.09 ,	1.19)	0.00		1.11	(1.06 ,	1.17)	0.00
Rural location	1.14	(0.96 ,	1.34)	0.13		1.08	(0.91 ,	1.28)	0.37
Home within 17 miles of clinic	0.99	(0.89 ,	1.10)	0.81		1.08	(1.00 ,	1.15)	0.05
Expected clinical need									
None	0.62	(0.55 ,	0.70)	0.00		0.31	(0.28 ,	0.35)	0.00
Very low	1.00					1.00			
Low	1.28	(1.16 ,	1.42)	0.00		1.38	(1.26 ,	1.50)	0.00
Moderate	2.28	(2.08 ,	2.49)	0.00		2.89	(2.66 ,	3.13)	0.00
High or very high	3.46	(3.11 ,	3.85)	0.00		4.49	(4.09 ,	4.93)	0.00
Insurance									
Private insurance	1.00					1.00			
Medicaid	0.80	(0.67 ,	0.95)	0.01		0.43	(0.38 ,	0.50)	0.00
Medicare	0.98	(0.90 ,	1.07)	0.65		0.94	(0.87 ,	1.01)	0.07
Female PCP	1.06	(0.95 ,	1.18)	0.30		1.19	(1.05 ,	1.34)	0.01
PCP's encounters through secure messages, %									
≤ 10	1.00					1.00			
10 to 20	1.21	(1.07 ,	1.37)	0.00		1.30	(1.14 ,	1.49)	0.00
20 to 50	1.94	(1.70 ,	2.22)	0.00		2.46	(2.14 ,	2.82)	0.00

SM use in patients with depression

Table 6 shows the adjusted results of SM predictors among patients with depression. Key points that distinguish these results from the overall Group Health population that uses SM include:

- Patients with rural homes were positively associated with SM use.
- PCP response time to SM of over 24 business hours was associated with less patient SM use.

Table 6: Adjusted analysis showing odds ratio of secure messaging use to non-use for patients with depression

	Comparison Group Not Messaging								
	ID Verified					Not ID Verified			
Characteristics	OR	95% CI		p		OR	95% CI		p
Age, years									
18-35	0.92	(0.76 ,	1.13)	0.44		0.89	(0.78 ,	1.02)	0.10
36-50	1.00					1.00			
51-65	0.97	(0.83 ,	1.14)	0.74		0.94	(0.83 ,	1.06)	0.30
>65	0.52	(0.42 ,	0.64)	0.00		0.25	(0.21 ,	0.30)	0.00
Female	1.14	(0.98 ,	1.34)	0.09		1.02	(0.91 ,	1.14)	0.77
Rural location	1.57	(1.04 ,	2.37)	0.03		1.28	(0.99 ,	1.14)	0.06
Expected clinical need									
None	0.83	(0.27 ,	2.57)	0.75		0.75	(0.31 ,	1.81)	0.53
Very low	1.00					1.00			
Low	1.29	(0.53 ,	3.14)	0.57		1.82	(0.89 ,	3.74)	0.10
Moderate	2.29	(1.00 ,	5.23)	0.05		2.90	(1.47 ,	5.72)	0.00
High or very high	3.54	(1.56 ,	8.00)	0.00		4.48	(2.24 ,	8.94)	0.00
Insurance									
Private insurance	1.00					1.00			
Medicaid	0.63	(0.39 ,	1.02)	0.06		0.36	(0.25 ,	0.52)	0.00
Medicare	0.74	(0.54 ,	1.02)	0.64		0.76	(0.58 ,	1.00)	0.05
Female PCP	1.15	(0.94 ,	1.41)	0.16		1.38	(1.18 ,	1.61)	0.00
Average physician response time									
≤ 6 business hours	1.00					1.00			
7-12 hours	0.98	(0.81 ,	1.19)	0.83		0.94	(0.80 ,	1.09)	0.38
13-24 hours	1.01	(0.82 ,	1.25)	0.90		0.96	(0.78 ,	1.19)	0.71
Over 24 hours	0.65	(0.51 ,	0.83)	0.00		0.81	(0.65 ,	1.00)	0.05
PCP's encounters through secure messages, %									
≤ 10	1.00					1.00			
10 to 20	1.06	(0.83 ,	1.35)	0.63		1.39	(1.15 ,	1.67)	0.00
20 to 50	1.74	(1.33 ,	2.26)	0.00		2.25	(1.84 ,	2.76)	0.00

SM use in patients with congestive heart failure

Table 7 shows the adjusted results of SM predictors among patients with CHF. This analysis required a pared down model in comparison to the diabetes and depression analyses. Key points that distinguish this results from that of the overall Group Health population that uses SM include:

- Tenure with PCP of ≤ 3 years was positively associated with SM use.

Table 7: Adjusted analysis showing odds ratio of secure messaging use to non-use for patients with CHF

	Comparison Group Not Messaging								
	ID Verified					Not ID Verified			
Characteristics	OR	95% CI		p		OR	95% CI		p
Age, years									
>65	0.82	(0.56 ,	1.20)	0.30		0.35	(0.27 ,	0.47)	0.00
Female	1.06	(0.77 ,	1.45)	0.74		0.78	(0.60 ,	1.00)	0.05
Tenure with PCP ≤ 3 years	1.34	(0.92 ,	1.95)	0.12		1.52	(1.18 ,	1.96)	0.00
Tenure with PCP > 3 years	1.00					1.00			
PCP's encounters through secure messages, %									
≤ 10	1.00					1.00			
10 to 20	1.86	(1.24 ,	2.78)	0.00		1.23	(0.91 ,	1.66)	0.18
20 to 50	2.04	(1.18 ,	3.53)	0.01		1.90	(1.27 ,	2.83)	0.00

SM use in patients with diabetes

Table 8 shows the adjusted results of SM predictors among patients with diabetes. Key points that distinguish these results from the overall Group Health population that uses SM include:

- Middle-aged patients (36-50 years) were more likely to use SM.
- Compared to privately insured patients, Medicaid patients were considerably more unlikely to use SM, even when they had access to advanced online services (OR 0.36 p= .0.00).
- Compared to privately insured patients, Medicare patients were not significantly more unlikely to use SM.

Table 8: Adjusted analysis showing odds ratio of secure messaging use to non-use for patients with diabetes

	Comparison Group Not Messaging								
	ID Verified					Not ID Verified			
Characteristics	OR	95% CI		p		OR	95% CI		p
Age, years									
18-35	0.97	(0.67 ,	1.40)	0.85		1.14	(0.86 ,	1.50)	0.00
36-50	1.00					1.00			
51-65	0.84	(0.72 ,	0.97)	0.02		0.77	(0.67 ,	0.88)	0.00
>65	0.49	(0.41 ,	0.58)	0.00		0.26	(0.22 ,	0.30)	0.00
Female	1.03	(0.91 ,	1.17)	0.63		0.78	(0.71 ,	0.86)	0.00
Home within 17 miles of clinic	1.08	(0.84 ,	1.37)	0.55		0.82	(0.68 ,	0.99)	0.04
Expected clinical need									
None	1.74	(0.38 ,	8.02)	0.48		2.12	(0.46 ,	9.90)	0.34
Very low	1.00					1.00			
Low	4.72	(1.11 ,	20.17)	0.04		4.82	(1.19 ,	19.51)	0.03
Moderate	6.64	(1.60 ,	27.64)	0.01		8.07	(1.98 ,	32.85)	0.00
High or very high	8.73	(2.12 ,	35.91)	0.00		10.41	(2.58 ,	42.07)	0.00
Insurance									
Private insurance	1.00					1.00			
Medicaid	0.36	(0.21 ,	0.62)	0.00		0.36	(0.23 ,	0.56)	0.00
Medicare	0.88	(0.63 ,	1.25)	0.48		0.85	(0.64 ,	1.14)	0.28
Provider: Age quintile									
First	0.94	(0.63 ,	1.41)	0.78		0.72	(0.57 ,	0.90)	0.00
Second	0.73	(0.53 ,	1.02)	0.06		0.73	(0.56 ,	0.97)	0.03
Third	1.00					1.00			
Fourth	1.02	(0.75 ,	1.40)	0.89		0.80	(0.66 ,	0.97)	0.02
Fifth	0.77	(0.58 ,	1.03)	0.08		0.77	(0.60 ,	0.99)	0.04
PCP's encounters through secure messages, %									
≤ 10	1.00					1.00			
10 to 20	1.35	(1.09 ,	1.68)	0.01		1.33	(1.12 ,	1.58)	0.00
20 to 50	2.68	(2.05 ,	3.51)	0.00		2.29	(1.88 ,	2.78)	0.00

Aim 2

Association between messaging use and diabetes quality of care. As in Aim 1, we defined a participant as a SM user if he or she sent one or more clinical secure messages to a Group Health care provider. SM as a primary predictor was bivariate—any SM use vs. none. Future analyses will look at the potential association of the volume of SM and quality of care indicators for diabetes. Table 9 shows the results of the adjusted analysis for the three quality-of-care indicators used by Group Health for blood pressure: LDL and hemoglobin A1c. These are early analyses that we are still actively reviewing. These analyses were adjusted for all significant predictors of SM use found in Aim 1 analysis as well general and diabetes specific comorbidity. Our hypotheses were confirmed for a positive association between SM use and meeting the management goals of:

- Hemoglobin A1C < 7% (OR 1.38, p = .00).
- LDL < 130 mg/dL (OR 1..21, p = 0.02)

Our hypothesis of better blood pressure control was not confirmed; we found no difference in BP control of ≤ 130/80 mmHg in patients who SM vs. those who do not.

Table 9: Adjusted analysis showing association between secure messaging use and quality of diabetes care

	predict BP ≤ 130/80 mm Hg				Predict A1c < 7%				Predict LDL < 130 mg dL			
	OR	95% CI		p	OR	95% CI		p	OR	95% CI		p
Age, years												
18-35	1.70	(1.24 ,	2.32)	0.00	0.81	(0.63 ,	1.04)	0.10	0.71	(0.50 ,	1.00)	0.05
36-50	1.00				1.00				1.00			
51-65	1.06	(0.94 ,	1.21)	0.34	1.23	(1.09 ,	1.38)	0.00	1.75	(1.48 ,	2.07)	0.00
>65	1.01	(0.86 ,	1.17)	0.94	1.89	(1.67 ,	2.13)	0.00	2.65	(2.18 ,	3.21)	0.00
Female	0.88	(0.81 ,	0.96)	0.00	0.90	(0.83 ,	0.98)	0.02	0.62	(0.54 ,	0.70)	0.00
Rural location	1.18	(0.91 ,	1.53)	0.21	0.96	(0.74 ,	1.25)	0.78	1.35	(0.80 ,	2.27)	0.27
Home within 17 miles of clinic	0.98	(0.83 ,	1.17)	0.86	1.02	(0.86 ,	1.21)	0.79	0.98	(0.76 ,	1.26)	0.88
Expected clinical need												
None	0.51	(0.22 ,	1.20)	0.12	0.36	(0.20 ,	0.66)	0.00	0.53	(0.17 ,	1.65)	0.27
Very low	1.00				1.00				1.00			
Low	0.54	(0.26 ,	1.13)	0.10	0.63	(0.36 ,	1.09)	0.10	0.65	(0.23 ,	1.79)	0.40
Moderate	0.61	(0.30 ,	1.23)	0.17	0.87	(0.52 ,	1.47)	0.61	0.84	(0.31 ,	2.28)	0.73
High or very high	0.72	(0.36 ,	1.44)	0.35	1.10	(0.65 ,	1.86)	0.72	0.91	(0.34 ,	2.49)	0.86
Insurance												
Private insurance	1.00				1.00				1.00			
Medicaid	1.33	(0.92 ,	1.93)	0.13	1.25	(0.95 ,	1.64)	0.12	1.14	(0.73 ,	1.80)	0.56
Medicare	1.18	(0.91 ,	1.55)	0.22	1.09	(0.88 ,	1.35)	0.43	0.90	(0.63 ,	1.30)	0.58
Complications of Diabetes												
none	1.00				1.00				1.00			
1	0.85	(0.74 ,	0.97)	0.01	0.72	(0.65 ,	0.79)	0.00	0.99	(0.84 ,	1.17)	0.93
2	0.81	(0.70 ,	0.93)	0.00	0.55	(0.49 ,	0.61)	0.00	1.13	(0.94 ,	1.36)	0.20
3+	0.86	(0.75 ,	1.00)	0.05	0.46	(0.41 ,	0.51)	0.00	1.05	(0.87 ,	1.27)	0.62
Patient Secure Messaging Use												
No messaging, not ID-verified	1.00				1.00				1.00			
No messaging, ID-verified	1.06	(0.94 ,	1.19)	0.38	1.14	(1.04 ,	1.26)	0.01	1.27	(1.07 ,	1.51)	0.01
Messaging	1.10	(0.97 ,	1.25)	0.13	1.38	(1.25 ,	1.52)	0.00	1.21	(1.04 ,	1.41)	0.01

Discussion

Aim 1: Patients who used SM were largely the same patients that use other healthcare services. We found a few key exceptions, however, where SM users showed some distinguishing characteristics. These included less messaging activity among patients over the age of 65, patients on Medicaid and patients that had a PCP who messaged less with other patients. The Medicaid population and those over 65 years of age were less likely to use SM even when they had access to advanced MyGroupHealth services including the medical record. Factors

other than Internet access are likely contributing to the less frequent use in these populations. Our results also highlight the importance of the primary care physician in determining whether patients use SM, regardless of whether a patient can already access other advanced services on the portal.

We found limited differences between factors predicting use of SM among the general population compared to the three populations with chronic conditions. Physician response time of over 24 business hours was associated with less SM use among patients with depression but not in the other populations. This may have important implications for providers engaging this patient population through SM. It also reinforces Group Health's own policy of responding to patient SM by the end of the next business day. In contrast to the general population, patients aged 36-50 years with diabetes were also more likely than those aged 50-65 years to engage in SM. We need to understand more about this differential pattern of use, since diabetes has high prevalence and morbidity in the 50-65 year age group.

Aim 2: Our results show a small but significant association between SM use and better control of LDL and Hemoglobin A1c. While these results are encouraging, they should be cautiously interpreted for several reasons. First, our findings could be substantially swayed by unmeasured confounding. While we controlled for many factors known or thought to be associated with quality of diabetes care and with SM use, we were not able to control for some key known individual characteristics such as health literacy and computer skill. The observational nature of our study also raises the possibility that other unknown and unmeasured confounders were present that could further change our results. Last, we cannot assign a direction of causality. While it seems more likely SM use would lead to better quality of care, rather than better quality of care would lead to SM use, only carefully designed longitudinal studies or randomized trials could define the direction of causation.

This study aimed to look at how the addition of SM within an organization would be adopted and how it might impact the quality of care in the absence of its formal integration into disease management interventions. During this study period Group Health did not have an organized care management programs for diabetes that integrated SM. In this context, our results are encouraging and suggest the possibility that providing additional patient access through SM may help patients achieve better care for diabetes. Other studies looking at the formal integration of SM into online diabetes disease management programs are also showing encouraging results. Both observational and interventional studies currently encourage further study and implementation of patient-provider SM among patients with diabetes.

Limitations

The study had several limitations. We anticipated that users of SM would differ systematically from non-users in important characteristics such as prior use of health services, severity of illness, comorbidity, and sociodemographic characteristics. As noted above, these unmeasured confounders could have significantly swayed our results. Future studies should explore and establish in more detail patient, physician and organizational characteristics associated with SM use. Our study did not capture patients who use traditional e-mail (nonMyGH messaging) to communicate with their healthcare provider. At Group Health, however, traditional e-mail is used in very rare cases to communicate with patients. Traditional e-mail users are also actively encouraged to use SM to communicate with their healthcare provider. We limited our analysis to a bivariate measure of secure messaging. Future analyses looking at the association of secure messaging volume with patient characteristics and quality of care may differ from results presented here. We also could not address the substantive content of secure messages. Our study relied solely on automated data representing electronic exchanges between patients and providers. Future studies should determine what SM content is most relevant for safe and effective care of patients with chronic conditions.

Conclusions

- SM was more commonly used among patients with diabetes and depression in comparison to the general population of enrollees.
- Key predictors of a patient's SM use included age < 65 years, increasing expected clinical need and a PCPs use of SM with other patients.
- The addition of secure clinical messaging to existing patient-provider relationships may improve the quality of diabetes care.

Implications

Our findings support further use and investigation of secure patient-provider messaging in patients with chronic conditions.

List of Publications and Products

Posters

1. Carrell D, Ralston JD. Messages, Strands and Threads: Measuring Electronic Patient-Provider Messaging. Poster presented at: American Medical Informatics Association Annual Session, 2005; Washington DC.
2. Carrell D, Ralston JD. Patient Adoption of a Web portal at Group Health Cooperative. Paper presented at: HMO Research Network Annual Meeting, 2005; Santa Fe, NM.

Presentations

1. Ralston, JD Patient Use and Satisfaction with a Patient Web Portal. AHRQ National Conference, Washington DC, May 2006.
2. Ralston, JD Patient Web Portals: Connecting Patients and Providers at Home. NIBIB/NHLBI/NSF Workshop on Point of Care Technologies, April 2006; Crystal City, Maryland.
3. Ralston, JD Patient Centered Health Information Technology. American Medical Informatics Association Annual Session, 2005; Washington DC

Manuscripts in Preparation

1. Messages, Strands and Threads: Measuring Electronic Patient-Provider Messaging
2. Characteristics of Patients Using Patient-Provider Electronic Messaging
3. Characteristics of Patients with Chronic Medical Conditions Using Patient-Provider Electronic Messaging
4. Quality of Diabetes Care Associated with the Use of Electronic Patient-Provider Messaging

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