Final Report

Use of an Electronic Referral System to Improve the Outpatient Primary Care–Specialty Care Interface

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Preface

This project was funded as an Accelerating Change and Transformation in Organizations and Networks (ACTION) task order contract. ACTION is a 5-year implementation model of field-based research that fosters public–private collaboration in rapid-cycle, applied studies. ACTION promotes innovation in health care delivery by accelerating the development, implementation, diffusion, and uptake of demand-driven and evidence-based products, tools, strategies, and findings. ACTION also develops and diffuses scientific evidence about what does and does not work to improve health care delivery systems. It provides an impressive cadre of delivery-affiliated researchers and sites with a means of testing the application and uptake of research knowledge. With a goal of turning research into practice, ACTION links many of the Nation's largest health care systems with its top health services researchers. For more information about this initiative, go to http://www.ahrq.gov/research/action.htm.

Abstract

Background: Poor communication and coordination of care between primary care and specialty care providers leads to major inefficiencies in health care delivery. In resource-constrained settings, these inefficiencies exacerbate mismatches between the supply and demand for specialist services. The University of California San Francisco (UCSF) at San Francisco General Hospital (SFGH) developed a Web-based electronic and referral system (eReferral) staffed by specialist reviewers that allowed clarification of the consultative question, requests for additional evaluation, and triaging of appointment requests. We conducted a multimethod evaluation of a two-part intervention (extending the use of eReferral into the Renal Clinic at SFGH and making improvements designed to support primary care providers' use of the system).

Methods: Our evaluation of the eReferral system consisted of three components: (1) Secondary analyses of quantitative data from SFGH administrative systems plus data from quality improvement surveys of SFGH providers comparing indicators of accessibility, efficiency and quality of specialty care before and after the use of eReferral; (2) semi-structured interviews with eReferral users in primary care and in specialty clinics to assess attitudes toward eReferral and to identify best practices in implementing the system; and (3) simulation modeling to document the business case for implementing eReferral for specialty and primary care sites and to project the system's implications for healthcare costs and utilization of services.

Results: Analysis of the eReferral system logs demonstrated substantial initial decreases in wait times for routine new patient appointments for seven of eight medical specialty clinics. The changes in wait times resulted from increased appointment availability due to appointments "not initially scheduled" so that initial workup could be completed by primary care providers (PCPs), as well as from referrals that never resulted in an appointment, with advice to the PCP instead being delivered through eReferral. eReferral also enabled acceleration of more urgent care, with clinics having up to 37 percent of referrals expedited. Results of the surveys showed that specialists reported significant improvements in their ability to identify the consultative question and in appropriateness of referrals. Primary care providers reported that eReferral improved quality of care for their patients but that IT connectivity posed significant problems for some clinics.

User interviews revealed that most PCPs and specialists were satisfied or very satisfied with eReferral, despite a variety of challenges. A major driver of the system's acceptance was the perception that the system substantially improved access to specialty care, quality of care, and administrative efficiency in submitting and managing referral requests. These benefits were mediated largely by improved communication between primary care and specialty care providers. Uptake may have been enhanced by factors including mandatory use of the system (no paper alternative), the user-interface, which users perceived as intuitive and easy to learn; and process adaptations implemented by some practices. Finally, the development team was responsive in addressing system issues as well organizational issues that arose during implementation (such as onerous requirements for scheduling appointments that were imposed by one specialty clinic), and they conducted a relatively slow pace of rollout across the available specialty clinics. Negative consequences of the system that primary care users perceived were a shift in workload from primary care administrative staff and specialists to referring providers and the challenge of confirming appointments because patients no could longer get an appointment date immediately upon referral from the clinic staff. The latter

issue was particularly problematic in light of the large percentage of homeless and limited English speaking patients in the clinics' populations.

The work process models simulated the results expected from 1 year of referral processing in an average medical subspecialty or surgical clinic, with and without eReferral, assuming the same total volume of referrals are processed under both conditions (medical clinics averaged 854 annual referral requests, and surgical clinics averaged 1212 requests annually). Simulation results predicted that the system would reduce the number of specialist appointments needed to care for the fixed referral base by 29 percent for medical specialties and 33 percent for surgical specialties. To achieve this, specialist reviewers would spend an estimated 8.1 to 9.4 minutes per referral request (134 hours per 854 reviews of medical referrals and 164 hours per 1212 surgical referrals). For medical specialties, the total time specialists would spend reviewing eReferrals exceeded the estimated savings in specialist time spent on avoidable appointments and visits (76 hours per 854 referral requests) by 29 percent. However, there were also savings in staff time spent on referral processing, resulting in an estimate that eReferral would require net 9.5 percent additional labor costs compared with traditional paper-based methods. By contrast, in surgical clinics, eReferral reviews were conducted by nurse practitioners whose wage is significantly lower than a surgeon. Thus, the total cost of reviewer time (8.1 minutes per referral, 164 hours per 1212 surgical referrals) is substantially less than the surgeon time saved on appointments and visits (101 hours per 1212 referral requests, a 35 percent reduction), resulting a 22.5 percent cost reduction using eReferral. Primary care physicians spent 2.7 times more hours submitting, responding, and revising referral requests using eReferral compared with the system of paper-based referral requests. There were substantial savings in staff time in both specialty clinics and PCP offices. Overall, the labor costs were projected to be modestly higher for eReferral to medical subspecialty clinics and lower for eReferral to surgical subspecialty clinics.

Discussion: eReferral is widely viewed as a success, by specialists and referring physicians alike. The system has substantially improved access to specialty care and communication between specialists and referring physicians. Both specialty and referring-physician users perceived any differences in the time needed to for the eReferral process as valuable contributions to patient care. However, our model of the eReferral work process predicted that, on average, the time saved from avoidable appointments and other efficiencies was less than the time required to review the eReferrals. Thus, eReferral was predicted as net cost-saving only for clinics in which reviews could be conducted by less-expensive mid-level providers. A limitation is that the work process models have not been prospectively validated, for example, testing whether system design changes result in actual time and cost tradeoffs as predicted by the model. Establishing valid simulation models that can predict the costs and benefits of electronic referral system designs will be important for creating successful electronic referral systems in other settings of care.

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Introduction

The dysfunctional interface between primary care and specialty care in the United States often leads to suboptimal patient outcomes and to major inefficiencies in the delivery of health care. These inefficiencies lead to unnecessary demand on specialist services. This, in turn, makes access to specialty services more challenging, particularly in resource-constrained settings, where specialists are in especially short supply.

Information systems could potentially improve communication between primary care and specialist physicians by enforcing critical communications and by automating referral work processes. However, there is little literature reporting on such systems.

To act on the potential for information systems to improve referral processes, University of California San Francisco (UCSF)—San Francisco General Hospital (SFGH), San Francisco's main safety net provider of specialty care, has created a secure, **Web-based electronic referral system** ("eReferral") for submitting electronic referral requests to specialty clinics. Rather than submitting referral requests by fax or telephone, the referring provider completes an Internet-based form with the patient's relevant history and the referring provider's consult question. All relevant patient and provider information for each referral is automatically extracted from the electronic health record (EHR) at SFGH, the Siemens Lifetime Care Record (LCR), and is linked to the electronic referral request for subsequent review by a specialty clinician. Each specialty care practice designates a primary reviewer who triages each referral request and can communicate with the referring provider via the eReferral application. By channeling all incoming referrals for clinical review and creating a mechanism for iterative primary care–specialty communication, eReferral is designed to eliminate inappropriate referrals, reduce premature referrals by ensuring proper and complete primary care workup prior to the patient's appointment in specialty care, clarify the consultative request, and identify and expedite urgent cases.

Initial implementation of this system for five specialty clinics at SFGH has shown promising early results, for improving specialty access and the timely delivery of critical services. This initial success suggests that the system is ready to be extended for wider use within SFGH and affiliated safety net provider organizations and that the lessons learned from this wider use could help other provider organizations to reduce waste and improve patient care.

The purpose of our AHRQ ACTION project was to assess how SFGH's eReferral system, and electronic referral systems in general, can best be used to support improvements in health care processes and outcomes. To accomplish this goal, the project consisted of three parts: (1) analyses of secondary data to compare indicators of the quality, efficiency, accessibility, and patient-centeredness of specialty care before *vs.* after the use of eReferral; (2) semi-structured interviews with qualitative analysis to assess distinctive implementation practices and to explore how these practices might influence the system's success or failure, and (3) work process modeling to estimate the net costs (vs. savings) and to document the business case for implementing eReferral for specialty and primary care sites. Our evaluation was also conducted in the context of a two-part **intervention** that (1) introduced the system in a new specialty clinic and (2) made improvements to enable greater use of the system by referring primary care providers at affiliated community health centers.

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Longitudinal Comparison of Quantitative Outcomes

Methods

System Description

To assess the impact of eReferral on quality, efficiency, and access, we analyzed data from a variety of secondary data sources, including eReferral system usage logs and 2 surveys that SFGH had previously conducted for purposes of program monitoring.

Distribution of eReferral Triage Decisions. After reviewing a referral request, the specialty reviewer chooses one of three possible disposition options:

1. Schedule for the next available appointment (routine).
2. Schedule for an "Overbook" appointment, sooner than the next available. Prior to eReferral, this option was only available if the primary provider paged or called to speak with one of the specialists.
3. Do not schedule the patient, pending further information from or management by the referring provider. For these "Not Scheduled" cases, the reviewer writes back to the referring provider, asking for additional information or workup (e.g.: "please obtain a full set of thyroid function tests, I will reevaluate when those are available"), for clarification of the consultative question, or to explain why the patient does not require an in-person specialty visit, either because the primary care provider can be advised to manage the condition (e.g., "you can increase the patient's dose of levothyroxine"), or occasionally because the referral could better be handled by another clinic. These "Not Scheduled" appointments may ultimately be scheduled as routine, overbooked, or deemed unnecessary (and never scheduled).

We assessed the percentage of electronic referrals that resulted in overbook appointments, the percentage that were not scheduled after the initial review and, within the latter group, the percentage that were never scheduled (defined as a referral that did not result in an appointment within 180 days after the last exchange between the referring provider and the specialist reviewer).

Wait Times to Next Specialty Appointment. We used eReferral system logs to assess median wait times, defined as the time elapsed between initial referral submission to completed appointment, for each specialty clinic by month.

Reviewer Time Spent on eReferral. Aside from the initial application development and implementation costs, specialist reviewer time is the single largest expense in maintaining our system. We used two different measures: reviewer self-report and query of the eReferral database.

For the reviewer self-report, we distributed an electronic tracking sheet and asked the reviewers to mark in 15-minute increments time spent on eReferral-related activity for one representative week each month. We asked that they include all activities related to reviewing and responding to eReferrals, including review of medical records and pages and phone calls to PCPs.

We also queried the eReferral usage logs to obtain a systematic assessment of time spent directly using the eReferral system. The system tracks each time a reviewer makes a change to an electronic referral. The time spent by the reviewer between two changes is considered an interval; we added these intervals together to obtain the time spent reviewing. If a single change occurred without a subsequent change within the next 60 minutes, we valued this at 3 minutes, the average value for all reviewer intervals.

Both types of data were collected for 3 specialty clinics over a 5- to 7-month period, from June 2007 to January 2008 for Cardiology and Endocrine, and from February to June 2008 for Renal.

User Surveys

Specialty Visit Survey. To monitor the effect of eReferral on specialty care, SFGH conducted a short (less than 1 minute) visit-based survey comparing referral appropriateness, previsit evaluation completeness, and consultative question clarity before and after eReferral. The SFGH team attached the six-item questionnaire to the charts of all new patients at randomly selected specialty clinic sessions. In almost all cases, for each clinic, they had roughly equivalent numbers of questionnaires completed before and after the initiation of eReferral. (In one clinic, GI, SFGH had questionnaires completed only after the initiation of eReferral). They asked the first specialty provider (medical student, resident, fellow, Nurse Practitioner, or attending physician) who saw the patient to fill out the anonymous questionnaire. The questionnaire asked the providers to report their level of training and whether the patient was referred via eReferral. It then asked them to assess whether they felt the referral was appropriate, whether the consult question was clear, and whether a followup appointment was needed. If a followup appointment was needed, they asked whether a followup visit could have been avoided if there had been additional evaluation. We report summary results from this survey. A manuscript reporting these results in more detail is currently under review.

PCP Satisfaction Survey. In October 2007, UCSF researchers based at SFGH conducted a survey to assess primary care providers' (PCP) experience with eReferral. They sent an electronic questionnaire to all PCPs who refer their patients to SFGH for adult specialty care and have access to the SFGH EMR. We report descriptive statistics from this survey. The SFGH team published these results in *Journal of General Internal Medicine* in 2009. (This publication had been previously planned and was not conducted with support from AHRQ.)

Results

Usage of E-Referral and Disposition of Requests

As shown in Table 1 and 2, in eReferral volumes differed substantially among the clinics, ranging from 20 per month for breast evaluation to 250 per month for orthopedics.

Table 1. Usage of the E-Referral system by specialty clinic, January 2007-June 2009, medicine subspecialties

Medicine subspecialties	Average Volume (Referrals /Month)*	% Overbooked†	% Scheduled Routine†	Initially Not Scheduled: % Total	Initially Not Scheduled: Later Scheduled‡ %	Initially Not Scheduled: Never Scheduled‡ %	Initially Not Scheduled: % Unknown Status
Cardiology	88	24.4	53.6	21.8	5.7	16.1	0.3
Chest	43	9.4	63.3	25.4	7.6	17.8	1.9
Endocrinology	47	14.0	26.9	58.2	17.4	40.8	0.9
Gastroenterology	229	14.2	50.0	35.4	10.1	25.3	0.4
Hematology	34	10.5	50.2	38.9	7.5	31.4	0.5
Liver	53	1.4	31.4	67.1	14.0	53.1	0.1
Neurology	120	7.6	83.4	8.9	4.5	4.4	0.2
Renal	40	0.8	51.5	47.4	16.0	31.4	0.3
Rheumatology	46	36.7	38.8	24.2	6.3	17.9	0.3

* Referrals initiated in may 2008 are included in the average volume, but excluded from all "% scheduled" calculations.
‡ Subsets of the "initially not scheduled" total.
† On initial review.

Table 2. Usage of the E-Referral system by specialty clinic, January 2007-June 2009, medicine subspecialties, surgical subspecialties

Surgical subspecialties	Average Volume (Referrals /Month)*	% Overbooked†	% Scheduled Routine†	Initially Not Scheduled: % Total	Initially Not Scheduled: Later Scheduled‡ %	Initially Not Scheduled: Never Scheduled‡ %	Initially Not Scheduled: % Unknown Status
ENT	187	22.3	45.6	31.9	10.8	21.1	0.2
Neurotrauma/ surgery	33	15.7	49.4	34.1	10.6	23.6	0.8
Orthopaedic Surgery	250	10.9	55.3	32.9	14.2	18.7	0.9
Plastic Surgery	39	1.1	76.7	22.2	7.5	14.8	0.0
Podiatry	52	0.1	81.5	17.5	6.5	11.0	0.9
Urology	127	6.4	61.0	32.0	13.0	19.0	0.6
Breast Evaluation	20	1.1	63.6	34.8	5.5	29.3	0.5
Gynecology	186	7.1	61.5	31.3	12.6	18.7	0.1
Obstetrics	25	19.1	49.5	32.4	10.8	20.6	
MRI	309	46.3	31.0	17.6	9.5	8.1	5.1

* Referrals initiated in may 2008 are included in the average volume, but excluded from all "% scheduled" calculations.
‡ Subsets of the "initially not scheduled" total.
† On initial review.

Triage to Overbooked Appointments. Clinics used the overbook function (representing the new triage function of eReferral) at markedly different rates, ranging from 1 percent for Renal, to 14 percent for Endocrine and 47 percent for MRI (Table 1 and 2). Differences in overbook rates are largely attributable to two factors. The first is the nature of the clinical services: certain specialties tend to care for disease states that more often require expedited care. The second is differences in wait times: clinics having short wait times for the next available routine appointment are more likely to have appointments available for cases that need expediting. The latter effect was in evidence for some clinics which had decreases in overbook rates in step with their in wait times. Expedited care in the Renal clinic was not captured by the overbook function in eReferral, however, because they reserved one slot in each clinic session for "urgent" appointments, and the reviewer could instruct the scheduler to use that appointment, without using the overbook function.

Triage to "Not Scheduled." The percentage of referrals that were "Not Initially Scheduled" ranged between 9 percent for neurology to 67 percent for liver clinic. This category represents a one-time saving of an appointment, given that before the implementation of eReferral, these referrals would have all resulted in an appointment. In general, one quarter to one half of these "Not Initially Scheduled" referrals were subsequently scheduled after additional review. Essentially, these referrals would have led to a premature or unnecessary specialty visit had it not been for the eReferral system.

Referrals were considered "Never Scheduled," if no appointment had been scheduled within 180 days after the last specialist reviewer response to questions or discussion from the referring provider. ("Never Scheduled" referrals represent a "permanent" savings in appointments that are never made.) Because eReferral allows for iterative communication between the specialist and the referring provider, and because the referring providers can always respond if they disagree with the specialist's decision to not schedule the patient, we view "Never Scheduled" electronic referrals as those in which there is consensus between the referring provider and the consultant that the appointment can be safely avoided. The total proportion of electronic referrals "Never Scheduled" ranged from 4 percent for neurology to 53 percent for liver clinic.

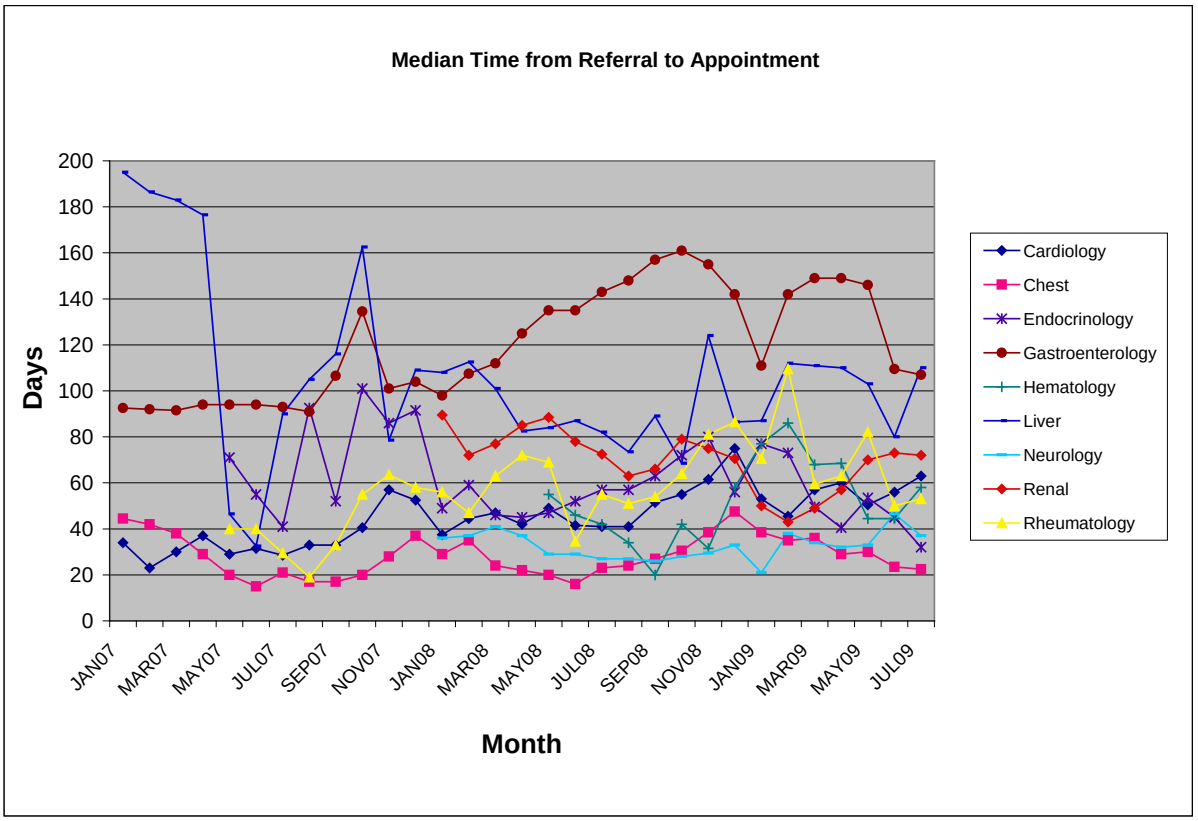
Together these data demonstrate the impact of eReferral on clinic efficiencies. Averting unnecessary or premature specialty visits resulted in decreased wait times for routine appointments. This in turn decreased the use of overbook appointments, resulting in improved clinic flow and a more efficient and rational use of clinical resources. When reviewers overbook patients, they are adding patients onto an already full schedule of patients and are forced to do so without taking into account staffing or space availability. This results in unpredictable, overly busy clinics, with increased stress for both clinicians and support staff.

Outcomes Related to Accessibility of Care

Change in Wait Times for Routine New Patient Appointments. During the first 6 months after implementing eReferral, median wait times for nonurgent visits declined in 7 of 8 medical specialty clinics by up to 90 percent (range 17–90 percent, all but one greater than 60 percent) without any significant increases in specialty capacity. In the cardiology clinic, on the other hand, wait times actually increased by 34 percent, from generally under 40 days to mostly in the range of 40-60 days. This difference may be attributable to the fact that Cardiology had a relatively larger supply of providers at the time when eReferral was launched, and experienced a modest reduction in the number of specialists staffing clinic. Cardiology wait times continue to be shorter for than for most other clinics.

Figure 1 shows the median wait times for each clinic by month from 2007 through the first half of 2009**.** After the initial 6-month decline (not shown for gastroenterology because it began more than 6 months prior to 2007), median wait times have begun to increase gradually across all clinics. This increase in wait times is correlated with an increase in the volume of electronic referrals, which in turn is attributable to intentional expansion of the safety net through the City's universal health care program, Healthy San Francisco which started in July 2007. As of October 2009, the program has enrolled more than 47,000 of San Francisco's estimated 60,000 uninsured residents. More than 25 percent of these participants are new to the San Francisco County delivery system.

Figure 1. Median times from referral to appointment for non-overbooked appointments in medical specialty clinics (excluding overbooked appointments but including the time spent in the review process itself)



No-show New Patient Appointments. We had originally postulated that decreased wait times would result in lower no-show rates.[1] However, no-show rates have generally remained high, and variations in these rates appear unrelated to the institution of eReferral (Table 2). Although no-show rates did appear to drop for Endocrinology after the start of eReferral, they dropped for the Renal clinic at about the same time (late 2007), but before the start of eReferral. For the Cardiology clinic (for which no-show data were only available post-eReferral), no-show rates have also fluctuated but have remained relatively high. This is despite the institution of an automated appointment notification letter sent out from the specialty clinic at the time that the eReferral appointment is made (in addition to the preexisting automated appointment reminder letter sent out 2 weeks before appointments). However, many SFGH patients have some degree of housing instability, and either have no address (if they are homeless) or an outdated address (if they have moved) on record; in one small audit of Pulmonary Clinic patients, up to a quarter of patients had an incorrect phone number listed in the EMR.

[1] One Scottish study performed a retrospective analysis of wait times for a pediatric ophthalmology clinic (range 22 to 392 days, average 70.6 days) and found that as wait times decreased, show rates increased. Of note, the study also divided the children into two groups based on class; the effect of wait time on show rates was more pronounced in the more deprived group. Bowman RJC et al. Waiting times for and attendance at paediatric ophthalmology outpatient appointments. *BMJ* 1996; 339:1244-1244.

Table 3. Proportion of new patient appointments not attended, by quarter

Clinic	Jan-Mar 2007	Apr-June 2007	July-Sept 2007	Oct-Dec 2007	Jan-Mar 2008	Apr-June 2008
Cardiology (1/1/07 start date)	27%	36%	35%	44%	37%	30%
Endocrinology (5/14/07 start date)	48%	34%	32%	38%	23%	33%
Renal (1/14/08 start date)	43%	49%	29%	34%	33%	36%

In the past, the majority of specialty appointments were made while the patient was in clinic and could therefore provide input as to his or her availability. In addition, if an appointment was scheduled for 9 months later, the patient had many months during which he could be notified/reminded of the appointment, and sufficient time to resolve any schedule conflicts. With eReferral, the patient is scheduled for the next available appointment without consideration of patient preference or availability. With such an arrangement, the shorter the wait time, the less likely a patient will be able to address any scheduling conflicts that may result in not showing for the appointment. Unfortunately, given the staffing constraints of the clinics, there is currently no way for the clerical staff at each specialty clinic to contact each patient before scheduling an appointment.

Cost-related Outcomes

Reviewer Time Spent on eReferral. Estimated eReferral usage times for reviewers, based on system log data, indicated that the Cardiology reviewer spent an average of 46 minutes/week on the system, the Endocrine reviewer spent 69 minutes/week, and the Renal reviewer spent 75 minutes/week. One driver of the reviewer's time on the system would be the proportion of patients who are not initially scheduled, as these require an online exchange through the eReferral system with the referring provider. The Endocrine and Renal clinics did have substantially higher rates of not initially scheduling referrals (Table 1).

Reviewers' self-reported times for handling all review tasks (including time spent on tasks such as finding relevant articles, referencing guidelines, and if needed, paging or calling the PCP), were nearly double the system log estimates for Cardiology and Endocrine, at 84 and 120 minutes/week, respectively. For Renal the self-reported estimates averaged 86 minutes/week, which was only 15 percent more than the system log result. One source of variation in this correspondence could be the reviewer's tendency to reference online knowledge resources and to conduct other related tasks at the same time they are conducting reviews with the eReferral system open.

Specialists' Assessments of Referral Quality and Appropriateness

SFGH collected 618 questionnaires, 413 from medical and 205 from surgical specialty clinics between May 2007 and November 2008. Referrals made through eReferral constituted 64.9 percent of all questionnaires collected from medical specialty clinics and approximately half (48.8 percent) of questionnaires from surgical specialty clinics.

Difficulty in Identifying Clinical Question. Medical specialty clinicians reported difficulty identifying the reason for consultation or clinical question in 19.4 percent of new patient visits referred via the paper-based method vs. 9.7 percent of new patient visits referred using eReferral (p-value 0.009). In surgical specialty clinics, clinicians reported difficulty in 38.5 percent (paper-based) *vs.* 10.0 percent (eReferral) of visits (p-value <0.001)

Appropriateness of Referral. Medical specialty clinicians considered the referral inappropriate for 6.3 percent of new patients referred via paper-based methods vs. 2.4 percent of new patients referred by eReferral (p-value 0.08). Surgical specialty clinicians considered the referral to be inappropriate for 9.4 percent (paper-based methods) vs. 3.0 percent (eReferral) of visits (p-value 0.08). Thus, specialists found unclear consultative questions to be more frequent problems than inappropriate referrals. The use of eReferral was associated with substantial decreases in both of these problems, but the change in the inappropriate referral rate was not statistically significant due to the low baseline rate.

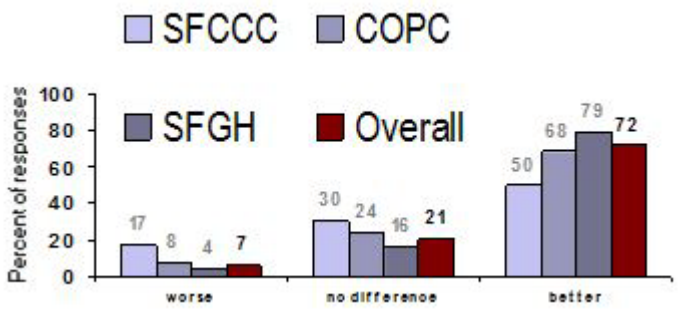
Need for and Avoidability of Followup. Medical specialty clinicians indicated that they requested followup for 84.6 percent of new patient visits referred via paper-based methods and 87.2 percent of new patient visits referred by eReferral (p-value 0.5). Of those cases that required a followup visit, medical specialty clinicians considered 30.8 percent of followup requests resulting from paper-based methods referrals and 21.9 percent of followup requests resulting from referrals by eReferral to be avoidable if a more complete workup had been done prior to the specialty visit (p-value 0.09).

In surgical specialty clinics, clinicians indicated that they requested followup for 76.2 percent (paper-based) and 59.2 percent (eReferral) of visits (p-value 0.01). Surgical specialty clinicians considered 43.0 percent (paper-based) and 14.3 percent (eReferral) of followup requests to be avoidable (p-value <0.001). Thus, surgery clinics had a larger proportion of followup visits under the paper-based referral system that were deemed to have been avoidable, had a more complete workup been done prior to the appointment, and this decreased substantially under eReferral, with a corresponding drop in the proportion of surgical visits requiring followup. Avoidable followups were somewhat lower at baseline among medical subspecialty clinics, and they also decreased less with eReferral.

PCPs' Assessments of the Referral Process and Communication

SFGH surveyed all 368 eligible PCPs who practiced at a San Francisco Community Clinic Consortium (SFCCC) site, a San Francisco Department of Public Health (SFDPH) Community Oriented Primary Care (COPC) clinic, or a San Francisco General Hospital (SFGH) primary care clinic. These represent the core network of primary care sites that refer to SFGH for specialty care. The SFGH primary care clinics are funded by the SFDPH and are staffed by UCSF resident physicians and attending physicians; the COPC clinics are SFDPH funded community-based clinics that share an electronic health record with SFGH; they are staffed by SFDPH physicians and nurse practitioners. The SFCCC is a consortium of independently funded clinics serving the low income population of San Francisco. Clinical staff are employees of their respective clinic. Of the 368 eligible PCPs, 295 (81 percent) completed the survey. Highlights of our findings in analyzing the survey results are presented here.

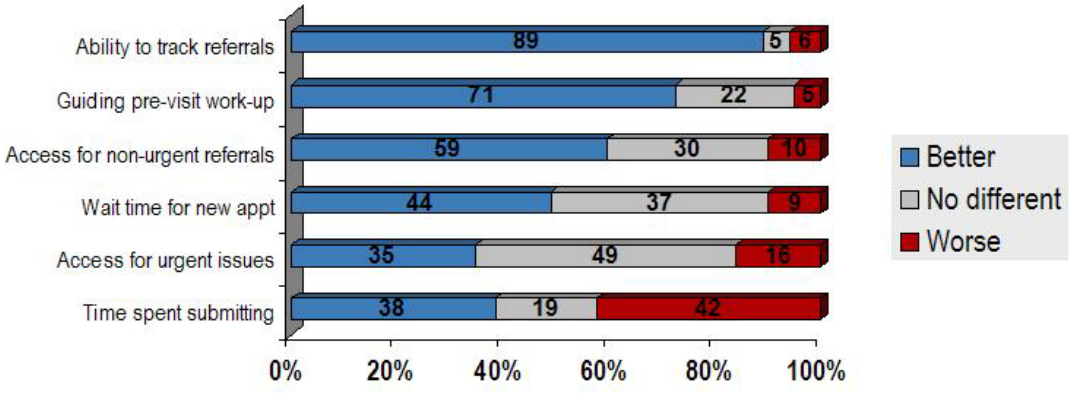
Figure 2. Distribution of PCP responses to the question "Overall, how has eReferral changed clinical care for your patients?"



Overall Impression. PCPs mostly perceived that the eReferral system had improved care overall (Figure 2). Among subgroups, there is a clear gradient among SFGH, COPC, and SFCCC respondents, with only 50 percent of SFCCC respondents reporting that eReferral had improved clinical care, while 17 percent felt that it had worsened care (Spearman, p=0.0000). In a multivariate analysis adjusted for training level, specialty (e.g., family medicine, internal medicine), clinic setting, affinity for newer information technology, and time spent submitting a referral, we found that Consortium clinics had significantly lower odds of reporting that care had improved (AOR 0.40, 0.18-0.91) compared to COPC clinics (AOR 0.72, 0.35-1.49) and the hospital-based primary care clinics. Based on survey comments and discussions SFGH has had with SFCCC providers, it appears that this less enthusiastic (although still largely favorable) view of eReferral is most strongly related to IT connectivity and access to the eReferral program/SFGH EHR. Supporting this is our finding that greater than 6 minutes spent per referral also predicted lower odds of agreeing that clinical care had improved (AOR 0.33, 0.18-0.61), even after adjusting for clinic setting.

Specific Benefits of eReferral. From the referring provider perspective, the major benefits of eReferral over prior paper-based referral forms were ability to track referrals, guidance of previsit evaluation, and improved access for nonurgent referrals. Compared with prior methods, approximately the same proportion of respondents felt that eReferral required more of their time as less time.

Figure 3. Distribution of PCP responses regarding specific effects of eReferral, compared with paper-based referrals



Additional Feedback. Approximately one third of respondents chose to provide unstructured feedback. These comments sounded five major themes: (1) poor connectivity or technical difficulties accessing the electronic referral system, particularly for Consortium providers; (2) frustration with the infrequency of electronic documentation among subspecialty providers; (3) logistical difficulties with ordering tests and relaying results to sub-specialists prior to obtaining an appointment; (4) appreciation for subspecialty reviewer guidance on workup of referral question; and (5) appreciation for the improved ability to track referrals. Providers felt that "the system is only as good as the reviewer" and that "eReferrals should require e-responses." Respondents also noted ongoing improvements to eReferral that have been made in response to referring provider feedback.

Use of eReferral by Referring Provider vs. Staff. When asked, WHEN they submit electronic referrals, respondents said that 16.6 percent (52) complete the electronic referral DURING the patient visit, while the patient is still in the office/clinic. 8.9 percent (28) complete the process BETWEEN patient visits, e.g., before seeing the next patient. 64.4 percent (203) complete the electronic referral AFTER patient visits, e.g., at the end of the work day or later, and 6.4 percent (20) have someone else (a non-PCP staff member) submit the electronic referral for them. 3.5 percent (11) of the respondents do not use eReferral to submit to specialists.

Discussion

These results document that the eReferral system enabled major improvements in referral handling, including a substantial increase in the capacity to see patients urgently when necessary (up to 37 percent of referrals were expedited) and a new ability to prevent unnecessary specialty visits. These effects, in turn appear to have enabled substantial improvements in access to specialty care, as assessed by wait times for routine new patient appointments. However, the fact that wait times increased for one subspecialty clinic (cardiology), associated with a decrease in staffing, illustrates the challenge of interpreting time series changes when no control group is available. Both specialists and primary care physicians expressed satisfaction with the system, with specialists reporting significant improvements in their ability to identify the consultative question and in appropriateness of referrals.

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Evaluation of Distinctive Implementation Practices

Background

We conducted semi-structured interviews with eReferral users in order to identify distinctive implementation practices among sites, and to provide collateral information that would inform assessment of the system's effects. Another goal of the interviews was to develop a more nuanced understanding of users' views about the benefits and drawbacks of eReferral. Users' expectations about or perceptions of the effects of organizational innovations is an important aspect of the success of technology implementations (e.g., Davis, 1989; Venkatesh V, et al, 2003). We assessed participants' overall attitude toward eReferral and their perceptions of the impact of the system on principal performance goals including prevention of inappropriate referrals, prevention of premature referrals, reduced wait time, and improved administrative efficiency. The eReferral system has the potential to affect many other processes and outcomes in primary and specialty care which may affect the business case for implementing such a system. Interview prompts addressed perceptions about the effects of eReferral on processes such as changes in workload or work roles and communication and coordination. New technologies also frequently have unanticipated effects (e.g., Trist and Bamforth, 1951; Sproull and Kielser, 1991); we also investigated both unintended negative consequences and unanticipated benefits of eReferral.

To elucidate implementation practices, the interviews focused on technical and organizational factors that are typically associated with successful uptake of new information technologies. Assessment of organizational factors, in particular, is absent in many studies of health information technology uptake and effects (Chaudhry, 2006). Based on previous research (Davis, 1989; Sun and Zhang, 2006; Venkatesh et al., 2003; Straus, Bikson, Balkovich, & Pane, 2009) we included questions regarding: (1) technical factors, particularly as related to system ease of use (e.g., user interface, network reliability, computer access; integration with other systems); and (2) implementation factors, such as training, social influence, and perceived resource needs. We also asked participants for their recommendations regarding how to improve the system and its implementation. Not all interview questions were asked of each respondent; we varied the use of questions to ensure that the response burden was spread among interviewees in accordance with the Paperwork Reduction Act of 1995. However, some respondents provided information that addressed particular topics even if they were not asked. Our analysis is based on all such input, whether or not it was in direct response to our questions

Methods

Study Population

We conducted interviews with a sample of clinical and administrative staff in four primary care clinics and three specialty clinics. Sites were selected purposively as follows. The four primary care sites included a hospital-based clinic, a COPC clinic, and two SFCCC clinics. We chose two SFCCC clinics because, based on the PCP survey conducted by SFGH, Consortium clinics had more challenges with eReferral compared with the SFDPH funded clinics. All primary care practices had been using eReferral since July 2005, when the pilot with GI clinic began. To capture the experiences of specialist reviewers, we selected one

clinic (renal) that had not implemented e-referral at baseline, and two clinics that had previously implemented e-referral but that differed in patient populations and procedures; cardiology, which is a relatively high volume clinic (88 referrals per month), where the care tends to depend more on physical examination, and endocrinology, which has a smaller volume (47 referrals per month) and is more laboratory based. Cardiology began using eReferral in January 2007 and endocrinology in May 2007. In the renal clinic we interviewed staff both prior to their launch of e-referral, in January 2008, and again after approximately 1 year of use.

At each site, we recruited staff who use eReferral or whose jobs were affected by implementation of the system to participate in the interviews. In each of the four primary care practices, we recruited two physicians or nurse practitioners who used eReferral (eight interviewees), plus one staff member who acted as a coordinator of referrals (four interviewees). We also interviewed the office manager for two of the practices to obtain higher-level perspectives on labor and workflow changes (two interviewees). In each of the three specialty clinics, we interviewed the physician-reviewer and one nonreviewing physician (six interviewees). We also interviewed three staff people who were involved with scheduling visits in the specialty clinics. Thus, there were a total of 23 interview participants in the study.

We also conducted several followup interviews with individual physicians. Three of these interviews were conducted with referring providers in two SFCCC clinics in which an intervention was implemented in April 2009. The intervention consisted of installing an additional T1 line to improve e-referral access and reliability. These interviews focused on perceptions of whether access had improved as well as reactions to other enhancements to eReferral that had been made by the development team. In the renal clinic we conducted followup interviews with the physician-reviewer and with the nonreviewing physician regarding their post-implementation perceptions of the system.

Procedure

Interviews with referring providers and specialists lasted approximately 60 minutes and interviews with administrative staff lasted approximately 30 minutes. Referring providers and specialists were paid $100 and administrative staff members were paid $50 for participating.

Three interviews were conducted face-to-face, and the rest were conducted by telephone. Two researchers conducted seven of the interviews together (including the face-to-face interviews), and the remaining interviews were conducted by one researcher. All interviews were audio-taped with participant consent and transcribed. One interview was lost due to technical difficulties with the recorder, yielding a total of 27 transcripts.

Analysis

We developed a set of content codes to reflect the research topics described above as well as new themes emerging from the interviews. We applied these codes to the transcripts using Atlas.ti software. The content codes reflect five general themes; most of which include a number of specific categories. The general themes include: (1) overall attitudes toward eReferral; (2) effects of eReferral on performance; (3) effects of eReferral on work roles; (4) technical factors; and (5) implementation processes.

Two raters were trained on the content analysis scheme. Five transcripts were coded by both raters during training and differences in codes were discussed and resolved. The first

author unitized the transcripts, and both raters then coded 4 transcripts independently. Interrater reliability across all categories using Cohen's kappa was .61, indicating substantial interrater reliability (Landis & Koch, 1977). Raters discussed and resolved disagreements on categories with lower levels of agreement. In total, 9 transcripts were coded by both raters, and then one author coded 18 transcripts alone.

Below we summarize users' responses about the main themes and provide corresponding quotations from the interviews. Some text was deleted from the quotations in order to maintain anonymity of the respondents or to eliminate irrelevant information.

Results

Overall Attitudes

Overall attitudes toward eReferral were largely positive, both among primary care and specialty users. Responses from referring providers are consistent with the quantitative survey results reported in Section 1; other users also were generally or extremely satisfied with eReferral. Examples of generally favorable attitudes include:

> *"Well, I think there's no downside and I think that because there's no downside, even though there may not be a particular upside, I think it's accepted; it's well-liked. What's to argue with?" (specialty nonreviewing physician)*

> *"I think it's great. I think there's glitches which I can mention, but they're sort of easily solved." (specialty reviewer)*

Others were extremely positive:

> *"Love it. Love it. Love it. Love it. Love it." (referring provider)*

> *"It's fun. I have to say. It's a lot of fun … Someone e-mails me and I give them advice. They give me the information, and all I do is play doctor … There's a fair number of times, actually, where I have to look something up. So I get to learn. I get to think. I get to educate. I don't have to deal with all the things that are why physicians don't like being physicians anymore." (specialty reviewer).*

Only one participant, a referring provider, had unfavorable reactions due to the additional work for PCPs in submitting a referral. We address this point in more depth in "Work Roles" below.

Effects of eReferral on Performance

Reduced Demand for Specialty Care Services. Many interview participants reported that eReferral improved access to specialty care. Numerous interview participants reported that by using a specialist reviewer to review and triage referral requests, eReferral prevents premature and inappropriate referrals, for example those where the patient should have further diagnostic testing before being seen by the specialist, or the patient should be referred

to a different specialty service. This was viewed as a major benefit by specialists but was also seen positively by referring providers. Examples follow.

> *So if we can save ourselves a clinic visit by having say the ultrasound and a few lab tests … done by the time they arrive, you know, we're sort of one step ahead. Then, it's just a matter of booking the biopsy or whatever it is. Otherwise, you've got to do all that work first, bring them back, tell them, 'Okay, now we need to do the biopsy.' So you're able to eliminate at least one clinic visit in the beginning. (specialty reviewer)*

> *And then I think their visit is more productive because they've already done some of the initial diagnostic work. (referring provider)*

However, one referring provider reported reduction of premature referrals differs by specialty, and two participants reported that eReferral has had a minimal or no effect on this outcome.

Reduced Wait Time for Routine Appointments. Consistent with analysis of wait times reported in the subsection, Outcomes Related to Accessibility of Care, many interview participants—predominantly referring providers—reported that eReferral reduces patient wait time for routine appointments in specialty care. A few providers reported that the difference is significant, for example, "My sense, well, I can tell you, for GI, night and day. Liver clinic, night and day. It used to be 5 months to a year, now it's about 1 to 2 months."

Several referring providers and specialists also found that eReferral allows them to request an expedited referral or determine if a patient needs to be seen quickly. However, given the asynchronous nature of the eReferral process, the overall policy is that patients who need to be seen within 2 weeks should not be referred through the eReferral program. The mechanisms to accommodate more urgent appointments tends to vary by specialty. Some specialty clinics encourage referring providers to page a consultant to request appointments for patients that need to be seen urgently, and most specialists reported that they generally accommodate these appointments by overbooking. Other specialty clinics require eReferral for all referrals, and if the patient needs to be seen within the next day or two, they instruct the referring provider to send the patient to the emergency room or an urgent care facility (some specialty clinics include these instructions on their eReferral policy page). Nonetheless, interview participants reported that there are more openings available to accommodate urgent cases, regardless of this variance in implementation among clinics.

Enhanced Patient Safety and Health Outcomes. Many interview participants reported positive effects of eReferral on patient safety and health outcomes, largely because the system enables the reviewer to triage patients appropriately. Other effects of eReferral on patient health outcomes and safety include the ability to see patients in a more timely fashion due to reduced demand as well as to schedule urgent patients more quickly; opportunities to initiate treatment sooner because the initial workup has been completed prior to the first appointment in specialty care, reduced errors in information provided to the specialist; and improved patient adherence because the referring provider (with whom the patient has a relationship), rather than an "unknown" specialist, is ordering the workup.

Some referring providers, however, reported potentially negative effects of the system on patient health or safety. In one case, a provider was upset because the specialist reviewer would not provide advice or schedule an appointment by phone for an unusual and potentially emergent condition and insisted that the referring provider either use eReferral or send the

patient to the emergency room. (In this situation, the referring provider went around the system and called other specialists.) Another referring provider reported that eReferral has, in some ways, become "a victim of its own success" because the expectation of easier access to specialty visits leads inpatient teams to discharge sicker patients: "… the success of eReferral of getting people in sooner to subspecialty clinics is taking the place of what perhaps should have been an in-patient consult."

Administrative Efficiency. The benefits of eReferral on administrative efficiency were noted by numerous participants. Many of the respondents, particularly administrative staff, provided multiple examples of these effects, which occurred via reduced paper handling, less need for phone calls and faxes, fewer lost events/rework, elimination of illegible handwriting, and improved tracking, for example, a provider said:

> *So it just keeps everything organized. Everybody that I've ever read an eReferral on there's a list, and I can say, "Oh, I never received the eReferral, or we got the referral on a very specific date, and here's what happened." It really helps me track everything a lot more easily than what we used to have … It's an electronic trail that's very logically set up. (specialty reviewer)*

Not all users felt that eReferral has had a positive impact on administrative efficiency. A small number of interview participants felt that it was worse or that results were mixed, and several report no change. Some users thought that eReferral generates as much or more paper because the clinics print out hard copies of referral requests and subsequent communication and reports. A number of participants commented on the need for better features in eReferral to track referral requests, such as the capability to send updates to staff other than the referring provider. This feature has since been added; the referring provider now has the ability to delegate specific followup tasks to clinic staff. One referring provider also noted the need for an efficient means to alert the providers that prerequisite tests have been completed, i.e.:

> *"I'm not always notified that a patient has had such and such a test, or I have to be on the lookout for it. And then I have to remember to resubmit the eReferral once that test has been gotten."*

Some clinics created supplementary administrative processes to aid in tracking, described in more detail in the discussion of "Technical and System Design Factors" below.

Enhanced Communication and Coordination

Many interview participants reported multiple, positive effects of eReferral on communication, as illustrated in the following comment:

> *"I think it's a really—it is a potentially very helpful and efficient system for referrals. I say potentially because in a number of cases it's great that you can send information to the referral service and then get feedback in a timely manner that helps to triage the patient to them, also helps to educate the referrer, the primary provider who is referring in terms of other work up that should be done before hand, or other diagnoses that need to be considered. So I think it can be helpful on both sides that the triaging of referring patients and referral service and also educating the primary providers." (referring provider)*

Other examples of the benefits of improved communication and coordination described above include:

"One of the big issues that used to come up-and it sounds absurd but it's true-it would be very difficult to figure out what exactly the primary provider wanted to have answered … So that's not an issue anymore." (specialty reviewer)

"I think things don't get lost, and the providers feel like they actually have some[one] they can communicate with very easily without having to page the person or play voice tag on the voice mail system." (specialty reviewer)

The system was also perceived as helping comanagement between PCPs and specialists:

"That's another advantage for some of these patients who just won't come to our clinic; at least there's a mechanism where you can provide some support for the primary care provider who's stuck dealing with the problem." (specialty reviewer)

"So what happens is sometimes they get rejected or not scheduled, which is okay because sometimes it's a question. It's actually a communication, which I love because it goes directly to them. I get the answer in a couple of days." (referring provider)

Another frequently mentioned benefit of communication was opportunities for primary care providers to learn from specialists. Many users, both referring providers and specialists, mentioned the educational benefits of eReferral for primary care providers.

"I think most of the … eReferral people spend a fair bit of time explaining why we're asking for tests or doing things, and through that I think it helps providers learn how to deal with some of these problems better on their own." (specialty reviewer)

" … so I send my e-Referral with all the information … and they can say, 'Well, have you thought about this, have you thought about that? Can you find out about this A, B, C questions for the patient, and maybe one, two, three tests before we see them?' And that is great for me because that expands my repertoire and my understanding of how to work up this kind of condition in the future." (referring provider)

Whereas many participants discussed positive effects of eReferral on education of or for referring providers, specialists were much less likely to report that eReferral provided learning opportunities for them. Only a small number of specialists reported educational benefits. Examples included being able to learn what referring providers are willing and able to do, educate other specialists about their patient population, think about the case or look something up, or learn about the appropriateness of their advice through repetition and feedback by seeing a lot of cases in eReferral.

Another communication benefit mentioned was anticipatory guidance in that specialty clinic staff can give information to providers to convey to the patient prior to his or her appointment in specialty care. Some referring providers appreciated receiving feedback from an attending physician, which was perceived as more useful or credible than feedback from a nurse practitioner, resident, or office staff. Another referring physician reported that eReferral

provides a “safe environment” to ask “dumb questions.” A specialist reviewer remarked on the value of the electronic trail of communication, which “makes for much better interaction.”

Work Roles

Many PCP interview participants reported that the system has created more work for referring providers. This change has occurred, in part, due to shifts in workload from primary care administrative staff, who handled referrals prior to eReferral, to primary care providers, who must login and submit electronic referrals:

> *“It's more time taken out of the physician's day. It was a lot easier and quicker for me to write a consultation on the papers that were given to us by the hospital. Now I'm having to go through a longer process with a few more hurdles in it. Just mechanically if we have any problems with the computer. If General has any problems with the computer. If there's a problem with a patient's [ID] number. If the eReferral process suddenly disconnects, which happened quite a bit initially, and that has cleared up for the most part. So for me, I guess, my initial reaction was this was transferring work that was done by other people to the physician, and I wasn't very happy about it.” (referring provider)*

> *“If somebody missed an appointment I could just go back and tell the scheduler reschedule it. … Now I can't do that. He [the doctor] has to go back into his system and ask for it to be rescheduled because it's eReferral … So as a provider, normally, that's great and fine, but the whole point of the case management part was to help take a little of that load off of him …” (primary care administrative staff)*

However, administrative staff members reported less work or responsibility due to eReferral. For example, the office manager for one of the specialty clinics reported that eReferral has greatly reduced the need to handle scheduling problems, enabling greater attention to clinic operations. A scheduler in specialty care reported that the time saved by eReferral enables administrative staff to work on a host of other tasks, such as answer telephone calls, troubleshoot patients’ issues such as medication refills and housing, and schedule procedures. Another specialty clinic scheduler reported being happy that s/he was not the person making decisions about which patients should be seen and whether they should be overbooked.

Some referring providers felt an additional sense of resentment at being forced to arrange preliminary tests that they didn’t think were necessary. One referring provider said:

> *“I get a request for a particular test, sometimes tests that I, having seen and examined the patient, do not think are indicated. But they will not be scheduled [to see the specialist] unless they have gotten that test. … And then, again, the onus will be on me to call the patient, and [convince him or her to] get the [test].”*

As noted previously, the referring provider also needs to be on the look-out for test results and resubmit the eReferral request when the results are available.

Despite these shifts, referring providers’ attitudes toward the system were generally positive due to effects of the system on quality of care and efficiency, for example:

"I think some people have been less eager to adopt it because it takes a little bit longer on the front end to make that referral. It's easier to grab a sheet of paper, write a quick sentence, and give it to your nurse to schedule an appointment. It takes a little more effort to get on the computer, to work through the various screens. But I think it's worth it. I think you get more out of it in the long run. You're … directly communicating with a specialist and they are reviewing all the referrals and they're … triaging the appointment times. It used to just be every referral got at the end of the line. And now they're actually reviewing cases individually and prioritizing them appropriately."

Moreover, two of the referring providers interviewed at follow up reported that they became accustomed to eReferral, "… it's just a different process … " and that eReferral does not impose unreasonable demands on their time. In fact, one provider felt strongly that the system saves time overall by eliminating the need to rewrite referral requests which had been necessary for lost paper referrals and for frequent no-shows in his clinic's patient population.[2]

Specialty reviewers generally did not object to the time required to review referral requests. One key consideration is that, in contrast with referring providers, they are explicitly compensated for their time. Only one reviewer remarked that eReferral creates additional work if the referring provider doesn't respond to a request for information, resulting in the need for the reviewer to be on the lookout for a response and follow up with the referring provider. This reviewer also raised the question of whether this raises a legal issue regarding who is responsible for the patient—the referring provider or the specialist.

eReferral also has had a significant effect on workflow by changing the referral process from a continuous processing to a batch processing mode, which in turn has resulted in unintended negative consequences on the ease of notifying patients about their appointments in specialty care. Prior to eReferral, the primary care practice staff typically scheduled an appointment with the specialty clinic while the patient was present. With eReferral, appointments are made after specialist review with minimal knowledge of patient availability. The specialty clinic sends the patient an appointment notification letter (essentially assuming that patients will make themselves available) plus a reminder letter 2 weeks before the visit. At some primary care clinics, staff there must also notify patients of the appointments, due to the large percentage of patients who are homeless or do not have reliable contact information; speak a variety of languages; and/or may be more likely to ignore a letter than personal communication. In fact, one referring provider reported that clinic staff tells patients to come back to the clinic in a week or two to find out their appointment time. Some primary care staff also sends letters to notify patients in their primary language of their appointments in specialty clinics because the primary care staff is concerned that the specialty clinic letter will not be sent or will not be understood because it is in English.

Technical and System Design Factors

Technical characteristics of systems typically influence with how easy or difficult it is to use the system. Ease of use, or "effort expectancy," influences behavioral intentions to use new information technologies (e.g., Venkatesh et al., 2003). We describe participants'

[2] Originally the system required the referring provider to start a new referral request for patients who had missed their appointments in specialty care. The eReferral development team added a feature that enables referring providers to resubmit an existing request.

responses with respect to several aspects of the system related to ease of use including the user interface, network access and speed, and system integration. We also describe strategies that users adopted to deal with problematic design features of the system.

User Interface. Most interview participants reported that eReferral's user interface is very easy to use, that the system is "self-explanatory," "user-friendly," "intuitive," and "pretty good at walking you through the steps you need to go through, prompting you." Nonetheless, a number of users reported various system design issues—several of which were resolved during the course of this study. Examples of design issues are listed below. Issues marked with an asterisk were addressed in subsequent iterations of eReferral:

- Failure to notify referring provider if a patient is a no-show. No-show appointments were flagged in red on the eReferral worklist, but providers didn't receive an automated message about no-shows and some perceived that they had to call the patient or ask the patient on his or her next primary care visit to find out if they kept their appointment.
- The inability for someone who initiated communication to send another message until the recipient replies to the previous message.* (A feature was later added enabling referring physicians to add information prior to the review. However, specialists still must await the referring physician's reply for additional communication.)
- Notification of an appointment sent only to the referring provider—other primary care staff are not notified. This is particularly problematic if the referring provider is a resident who is not in clinic on a regular basis. Likewise, if the specialist following the patient is a fellow who works in several locations and no other providers in the specialty clinic receive updates about a patient, coordination of care may be delayed.*
- The inability to save a draft of the electronic referral, resulting in the need to reinput the information if the system times out or goes down or if the user exits the system before submitting the referral request.*
- Inability to resubmit a referral request if the patient misses an appointment—instead the referring provider must submit a new referral request.*
- Inability to specify dates or times that patients are or are not available to be seen in specialty care.*

Network Access and Speed. Other usability issues pertained to network access and connection speed. Several participants reported access problems or difficulty logging in due to the need to log in to multiple systems, the inability to access the system remotely, or slow connections. A number of participants reported frequent or periodic system outages, although most indicated that outages were not lengthy or disruptive, and others reported minimal or no such outages. (System outages were due to the LCR, not eReferral per se.)

In the two intervention clinics, none of the referring providers we interviewed were aware that a T1 line had been installed. Responses to questions about changes in system speed and reliability were mixed. One user reported that the system no longer crashes, whereas the other two participants noticed some improvement in speed but continued problems with system outages.

System Integration. A number of users reported difficulties using eReferral due to a lack of integration with other systems or data sources. Lack of integration was mentioned most frequently with respect to other sources of data on the LCR and tracking the status of referral requests. Lack of integration made it difficult to track the status of patients' tests or review test results on the LCR. For example, a referring provider reported that initially, s/he had to

exit eReferral to view imaging studies or lab reports—and if s/he was in the process of typing a referral request, the information would be lost (this feature has since been changed so that eReferral opens in a separate window). Others noted that eReferral does not provide notification if test results are available, which means that the referring providers must look in the LCR or be on the lookout for e-mail messages which inform the provider that a test has been completed and keep track of what s/he ordered, for example,

> *… so I might have to be remembering, oh yes, Mr. So-and-So needed that X-ray for me to send out the eReferral, so let me look through these four emails with 25 different results to make sure that he's gotten it so that then I can fill in the eReferral again.*

One specialty reviewer also reported that eReferral is not integrated with the clinic's online schedule system, making it difficult to check for available appointment times.

Supplementary Processes and Workarounds. Several clinics developed new processes to improve eReferral functionality. As described previously, the SFGH specialty clinics automatically sent out an initial notification letter and a 2-week reminder letter for each specialty clinic appointment but these letters were only generated in English and in addition some patients did not have reliable addresses. Staff in three primary care clinics therefore created logs or spreadsheets to track the status of referrals (e.g., date of appointment, patient notification). These spreadsheets were not part of eReferral at the time of our initial interviews and therefore users would enter data manually or to cut and paste fields from eReferral screens into spreadsheets. Staff monitored these spreadsheets for appointments that were not scheduled so that the referring provider could follow up. They also produced appointment notification and reminder letters in the primary languages of their patient populations (e.g., Chinese, Korean, and Russian). Subsequently, these tracking features were added to the eReferral worklists.

To respond to referrals that were submitted by fax after the change-over to eReferral, specialty clinics were given a stamp indicating the need to submit requests via eReferral and then faxed the stamped request back to the referring provider. This procedure was initiated to reduce the number of phone calls and e-mail messages from referring providers who questioned the requirement to use eReferral.

In addition to new work processes, some interview participants reported using workarounds. The most frequently reported type of workaround was "fudging" information in the referral request in order to get around some specialty clinics' scheduling requirements. For example, some referring providers would "check the box" indicating that the patient was willing to have surgery or report that tests were pending when the provider felt that the requirement was unnecessary or would substantially delay patient care, respectively. Other workarounds involved going outside of eReferral (calling or faxing) to request a referral or modify an existing request. One specialty reviewer reported that this was permitted when the referring provider did not have easy access to eReferral—and the fellow, rather than the referring provider—submitted the referral request, but the reviewer also described negative consequences:

> *"What will happen is [the referring provider will] tell the fellow the full story, and then the fellow would say, "Okay," and then put it through eReferral, and then I get one sentence. I don't know when to schedule a patient because I don't know enough details. (This reviewer subsequently told fellows to wait until they*

returned to the clinic and put these patients on their own schedules to ensure continuity of care.)"

Others reported using workarounds to deal with system design issues. For example, because referring providers had to submit a new referral request if the patient missed a scheduled appointment, they would call the specialty clinic at particular times of day because they knew that some staff would accept changes over the phone. In order to address the problem of not being able to reply within eReferral until the other party responded, a specialty reviewer made it a habit of saying, "Please tell me when [the test result] has been faxed" so that when the provider replied "faxed it," the reviewer could reply to that message.

Implementation Processes

Training. Most participants reported that they had informal training, which generally consisted of sitting down with someone from the implementation team or a colleague from their clinic who demonstrated how to use the system. Some participants reported that there was no training, i.e., they had to figure out how to use the system on their own. Most participants felt that the training was sufficient, largely because the system is easy to use. Only a small number of users remarked that they would have liked more formal training.

At the same time, followup interviews conducted after 1 year of use revealed that users were not aware of many of the new features of eReferral—in spite of prolific efforts to communicate system changes on the part of the development team. Thus, although most users seemed to be adept at using the basic features of eReferral, they may not have been exploiting the full functionality of the system.

Social Influence. Social influence from important others—such as leaders and co-workers—is a construct in a number of models used to predict technology adoption (e.g., Azjen, 1991; Davis, Bagozzi, & Warshaw, 1989; Venkatesh V, et al., 2003). We evaluated interview participants' responses regarding three types of social support for eReferral: presence of a champion for the technology; support from other leaders; and co-worker support.

In most cases, interviewees identified members of the eReferral development team as the technology champions, but some interview participants reported the presence of internal champions. Interviewees in two clinics identified their medical director as an internal champion; for example, in one clinic, the medical director demonstrated support for the technology by soliciting input from staff about the system at weekly clinic meetings, training the medical assistants, writing a policy manual for the clinic's use of eReferral, and developing procedures, including the tracking spreadsheet and notification letters in multiple languages described earlier.

Several participants described their medical leadership as accepting or supportive of the technology but some not necessarily as strong advocates, e.g., "He's quite supportive of it. He doesn't have any objections or anything like that . . . " Interestingly, one specialist commented on the importance of high-level leadership support, as follows:

"I think that [name], who is head of the department of public health, does like the system and thinks it's worthwhile. That's important because they're the ones who are going to provide the money to actually have physicians doing it. So I do think that they know about it and think it's important."

Several interviewees remarked that acceptance or support for the system grew out of seeing its benefits for others, e.g., “I think the reason why they’ve jumped onto the bandwagon is because they probably saw how efficient maybe it was with the GI.”

Other Facilitating Conditions. Interview responses identified other facilitating conditions for implementation (e.g., see Venkatesh et al., 2003). One of these was access to the system in terms of hardware and connection speed. Specialty clinics as well as some referring providers had sufficient access to hardware, and these users generally had no complaints about connection speed. Some primary care clinics, however, experienced inefficiencies due to a shortage of computers and lack of computer access in exam rooms. As a result, providers sometimes needed to shuttle between the exam room and the computer to get information from the patient for the eReferral or wait to input the eReferral until after the visit, which sometimes necessitated calling the patient for information. These users also reported problems with the connection “freezing.” Despite these problems, however, some of the users in these clinics were the most ardent supporters of eReferral.

Another facilitating condition was availability of technical support—although most users did report having technical problems, those who did generally found support staff to be responsive and helpful. Moreover, a number of users commented on the responsiveness of the eReferral development team in addressing suggestions from users. The team made numerous, ongoing modifications to eReferral to address design issues, such as providing a “scheduling considerations” field to specify dates or times when the patient is not available for an appointment, developing worklists that allowed nonclinical staff to track a provider’s referral requests, and adding an indicator to the provider’s work list that shows when there has been activity on a referral request. The team also facilitated changes in organizational practices; most notably, they brokered revision of some specialty practices’ policies for referral requests that were viewed as unreasonable by many referring providers. The team also conducted a series of site visits to both COPC and SFCCC clinics to demonstrate eReferral functions, and have instituted monthly SFGH-based drop-in trainings.

Finally, the manner in which eReferral was put into operation influenced its success. Undoubtedly, mandatory use of the system promoted adoption. However, even in large-scale organization adoption of information technologies, users will find ways to get around the system if it is difficult to use or has negative consequences (e.g., Halbesleben, Wakefield, and Wakefield, 2008)—which generally was not the case for eReferral. The pace of implementing eReferral also was important. The development team conducted an extensive pilot in one specialty clinic that provided opportunities to demonstrate benefits of the system to future adopters and to make modifications to the system before rolling it out to a larger set of clinics, and the subsequent roll out was staggered across sites rather than being simultaneous. The flipside of a phased roll out, however, is a lack of critical mass, and several users noted that it was difficult to keep track of which clinics were using eReferral and which were not.

Discussion

This case study provides rich documentation of the outcomes from a successful electronic referral program, and it suggests a range of design features and implementation factors that accounted for the program’s success. Users perceived that the eReferral system largely prevented the occurrence of low-value specialty visits due to unclear consult questions, incomplete workups, and referrals for problems that can managed in primary care. The system was also perceived as having markedly reduced wait times for specialty services,

which had previously been up to a year for some specialties in this historically under-resourced setting.

These successes could only be achieved, however, because referring PCPs and specialty reviewers were willing to invest their time using the system as intended rather than circumventing it. For most specialty reviewers, this investment was considered part of their compensated clinical time, and reviewers did not object to the nature of these tasks. However, referring providers were not compensated for the additional time required to submit and manage referrals, order preliminary tests, and manage or comanage patients. Some of these tasks were particularly burdensome for users in primary care clinics with poor technical infrastructure. Nonetheless, referring providers (as well as other users) were generally or extremely satisfied with eReferral. The chief factor accounting for their enthusiasm appeared to be the professional satisfaction of gaining improved access to specialty care for their patients. Another primary benefit of eReferral was that it enabled dialogue between referring providers and specialists, which provided PCPs with unique opportunities to learn and to gain reassurance that their patients' needs would be prioritized when necessary. This result was a direct product of system features that enabled asynchronous dialogue between the parties to the referral.

Although the perceived benefits of eReferral appeared to be the primary motivation for use, acceptance of the system also appeared to be influenced by an intuitive user interface that minimized training needs and by the development team's readiness to add or modify features in response to users' needs. A number of other implementation factors, including a measured pace of rollout, physician champions, and distinctive process adaptations used in some clinics also contributed to successful uptake of the system. Undoubtedly, mandatory use of the system also promoted adoption. However, even in large-scale organization adoption of information technologies, users will find ways to get around the system if it is difficult to use or has negative consequences (Halbesleben JR, Wakefield DS, and Wakefield BJ, 2008).This was rarely observed for eReferral.

The system appeared to have some unanticipated consequences on workflow. One was a shift in administrative tasks to PCPs. While the transfer of tasks such as test-ordering and patient management from specialist to PCP is arguably appropriate, the transfer of administrative tasks to PCPs was inefficient. A second problem identified in the interviews was the inability of patients to participate in setting the appointment times for their specialty care visits. This issue was particularly problematic for the large percentage of homeless and limited English-speaking patients in the clinics' populations. These effects of the system on workflow and work roles are consistent with other studies emphasizing the need for analysis of workflow and redesign prior to implementing health information technology. (Aarts J, Ash J, and Berg M, 2007; Bowens FM, Frye PA, and Jones WA, 2010). Individuals who design or implement HIT frequently consider the work process implications only after systems are implemented (Crosson JC, Etz R, Wu S, in press). Work process redesign should be accompanied by training to set expectations for changes in work roles and to ensure that practice members are familiar with new work processes.

Although workflow planning is important, it should not be equated with technology-centered development, in which users must change their work processes to accommodate features of IT systems. In the case of eReferral, however, development followed a human-centered approach (Horsky J, Zhang J, and Patel VL, 2005). The design team considered workflow at the system development stage. They used participatory design strategies, with key members of the development team being practitioners in primary and specialty care who had an intimate understanding of user needs. Perhaps most important, collaboration between physician-users and an in-house software team, in combination with ongoing evaluation, enabled continual improvement through system design changes rather than simply through

training and workflow adaptations. Coupled with the measured pace of roll-out and the strength of social influence, the design process may have enabled a virtuous cycle in which each specialty clinic added led to design changes that improved usability, thereby enhancing user perceptions of the system and increasing the demand for more specialty clinics to be brought online. This example stands in contrast to current EHR implementation plans in many healthcare organizations, where new systems are being implemented rapidly with limited opportunities to make changes in the system design.

An unsolved challenge in the eReferral implementation process is ensuring that users are familiar with system changes. We found that at least some users were unaware of system changes that had been made to correct initial problems, despite announcements and demonstrations of these features in outreach meetings, newsletters, and email broadcasts. Bundling changes and rolling them out on a less frequent or a more predictable schedule may be one strategy for helping users keep up. Another, more focused strategy would be to use system logs to identify users who are not taking advantage of new features in order to target training toward those individuals.

An important limitation of the study is its uncertain generalizability beyond the safety net delivery system, where specialists are salaried and where primary care providers face sometimes daunting challenges in obtaining specialty access. However, integrated delivery systems such as staff-model health maintenance organizations and possibly newer arrangements such as accountable care organizations have the power to create incentives for specialists and PCPs to compensate for the shifts in effort that eReferral would require. In addition, improved communication and coordination with specialists would likely be warmly welcomed by PCPs in most communities. The eReferral model may also be a useful tool in the Patient Centered Medical Home, provided that the incremental PCP time is adequately covered by the coordination fees included in that model.

The finding that specialists were able to shift their efforts toward higher-value services points toward the possibility of eReferral delivering economic benefits for any specialist. The challenges in settings where specialists compete and are not salaried would be for them to fill in the lost low-value services through gains in market share and to pay for the nonbillable time that they devote to conducting reviews. Future work is needed to address each of these challenges. Knowledge-based methods for collecting more structured data and for intelligent protocols could partially automate the review process, reducing the expense of the specialist review. At the same time, it would be critical to monitor and enhance the satisfaction of PCPs and patients with the referral process, using technology to enhance rather than degrade the sense of connection to the specialist.

Cost Estimation and the Business Case for eReferral

Methods

Using eReferral requires new care processes and labor inputs (e.g. specialist review of referral requests), which may have considerable cost implications. To estimate the net costs (vs. savings) and to assess the business case for eReferral versus the system of faxes and phone calls that existed prior to eReferral, we developed two discrete-event process simulation models: one for the paper system and the other for the eReferral system. We ran separate scenarios for medical subspecialty referrals and surgical subspecialty referrals, due to the use of physician as reviewers for the medical clinics vs. nurse practitioners as reviewers for the surgical clinics. The models were built using the Arena computer simulation system (Rockwell Automation, Wexford, PA).

In these models, referral processes are represented as a chronological sequence of events starting with a primary care provider (PCP) referring a patient and ending with the patient receiving an appointment with a specialist or leaving the referral process. The models each simulate a 1-year period of referral requests to the SFGH specialty clinics for which data was available from having implemented eReferral (nine medical subspecialties and six surgical subspecialties). Medical and surgical specialist care was aggregated across the individual subspecialties in each category to gauge the time, labor costs, and number of appointments consumed during the annual referral processes for the entire patient volume (854 initial referrals per year for the medical subspecialties, and 1212 initial referrals per year for the surgical subspecialties). These estimates allow a general assessment of the business case for implementing eReferral for specialty and for primary care practices, and of the impact on accessibility of specialist appointments.

Discrete Event Simulation

We performed discrete event simulation, which encompasses five kinds of events—a starting point, tasks, delays, decision points, and an end point. These were structured in each model to match the actual events that take place in the referral process, both in pre-eReferral systems and after the eReferral system is in use.

Starting Point. In the models, there is only one entering point, which is when a referral to a specialist is made. The rate was set to follow a Poisson process that matches the referral volume from the SFGH eReferral data (from the nine medical subspecialties and six surgical subspecialties).

Tasks. A task is a piece of work requiring effort and resources. The models defined all distinctive tasks involved in the referral process, including generation of referral requests, scheduling of appointments, and clinical evaluation of the referred patients to determine if further diagnosis or treatment is needed. Each task has three variables: a performer, task performance time, and outcome. For some tasks, all of the variables are modeled as deterministic (i.e., no randomness); but for others, some or all of the variables are modeled as stochastic (e.g., the amount of time to review a referral request). We used the survey data or expert opinion from SFGH to parameterize the task variables. Of note, given the enormous variability in clinical encounters, we did not include the actual specialty care delivered as

referral tasks. Rather, we included only the initial evaluation of referred patients to determine whether further diagnosis or treatment is needed by a specialist.

Delays. Delays are steps in a work process that consume time and have an outcome but do not involve any performer and hence no labor cost. Delays happen when, for example, a referral request is waiting to be reviewed by a reviewer or a patient whose referral was approved is waiting for an appointment with a specialist. In the current models, delays cause time to elapse but do not create additional direct cost penalties. In reality, delays would sometimes result in poor patient outcomes due to delays in care, cause an increase in the rush of use, but the available data and clinical heterogeneity didn't permit us to include this potential cost in our models.

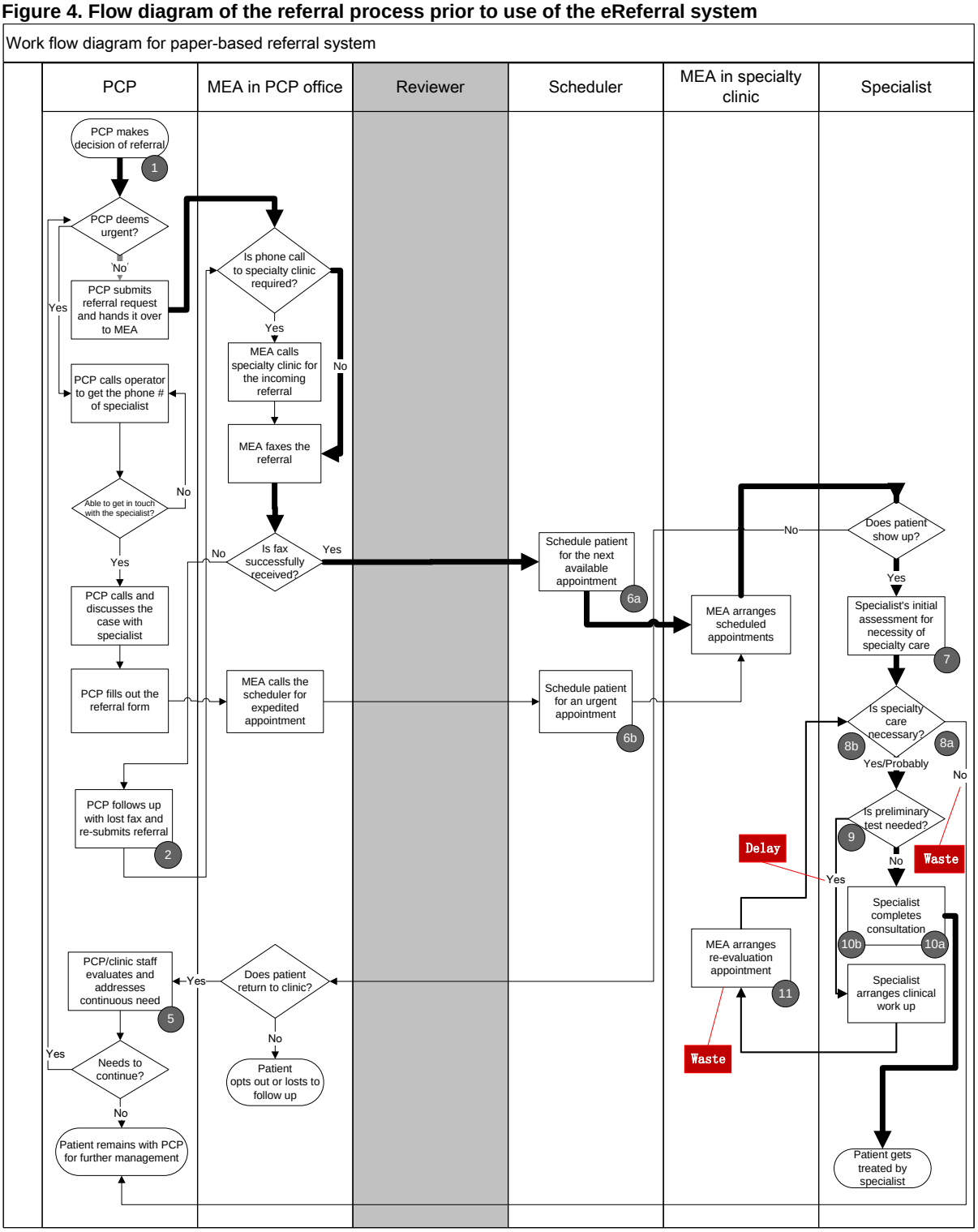
Decision Points. A decision point is a step in the process whereby a task performer deliberately chooses a specific course of action or an event occurs by chance that determines the ensuing course of action. In the models, the critical decision point is the event in which a specialist reviewer decides the disposition of a referral request, triaging it as unnecessary, premature (requiring further workup), or necessary (and therefore scheduled).

End Points. An end point is the event by which a process is deemed completed. There are three possible end points in the models: (1) patient gets treated by a specialist; (2) patient sees a specialist who decides that a visit could have been avoided or can be managed by patient's PCP and thus patient exits the referral process; or (3) patient opts to leave the referral process or is lost to followup.

The flowcharts depicting pre-eReferral and post-eReferral processes by task performers are presented in Figures 4 and 5 The potential waste and delay in the pre-eReferral system are indicated in Figure 4. In Figure 5, the new tasks created by the eReferral system are shown in red text.

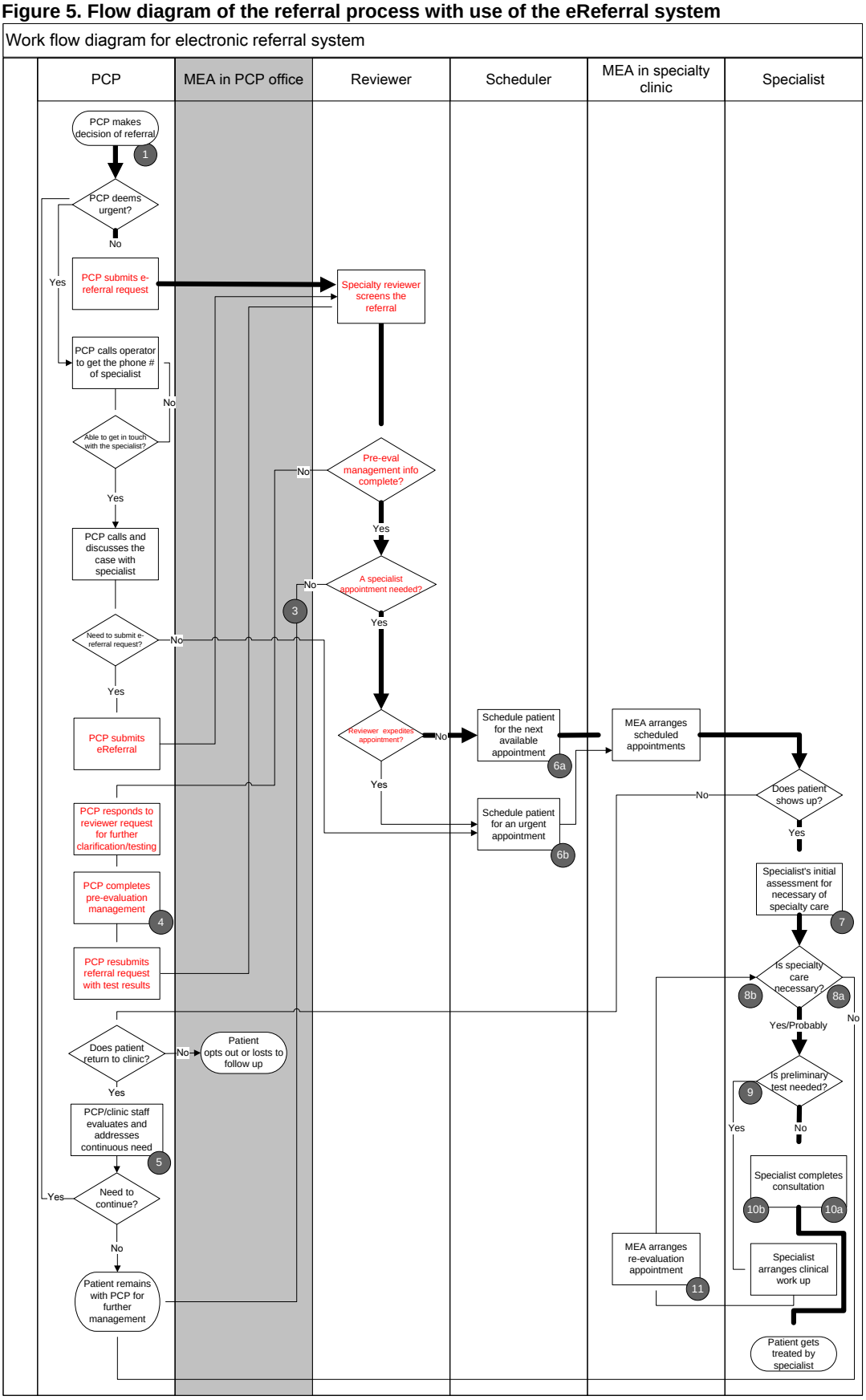
The simulation of the pre- or the post-eReferral processes was performed for the annual volume of patients referred by PCPs to an average medical or surgical specialty clinic. That is, one run of simulation in the medical department represented 52 weeks of referral process using the weighted average statistics of referrals in all 9 medical subspecialties. Likewise, one run of simulation in the surgical department represent annual referrals to the 6 surgical subspecialties. Each process is run 100 times to minimize the variation. We take the mean of the following outputs as our final result: providers' time consumptions, associated costs, and appointments made for the entire cohort of patients.

Figure 4. Flow diagram of the referral process prior to use of the eReferral system



Note: Thick lines indicate main process flows. Numbered circles correspond to events in Tables 5. Processes that are considered major waste and delays are indicated.

Figure 5. Flow diagram of the referral process with use of the eReferral system



Note: Numbers correspond to Tables 5. Red text shows new processes in eReferral.

Model Parameters

The basic parameters of the simulation models include the patient entering rate, processes parameters, decision point probabilities, and performers' information.

Patient Entering Rate. Our simulation is a continuous time-based model, with new patients entering the system in each time period (when a referral is deemed necessary by the patient's PCP). The entrance rate is a Poisson process. We set the rate from the weighted average of the nine medical subspecialties (which is 854 patients per year) and the six surgical subspecialties (which is 1212 patients per year).

Process Parameters. Process parameters are properties of tasks and delays, e.g., how long each task takes and who performs the task. For most tasks in the model, the elapsed time to perform the task is assumed to be a uniform distribution in the time range estimated by the SFGH experts. For some important processes for which observational data were available, we fitted the data with gamma distributions in order to obtain more precise processing time. Specific inputs are listed in the Appendix.

Probability. Probabilities are properties of decision points. Estimates of the decision point probabilities are shown in Table 4. They are based on the SFGH survey, eReferral system log, or discussion with eReferral key informants at SFGH. A key difference in probabilities between the two systems is the rate of urgent cases that require a phone call between PCP and a specialist. In paper-based system, one-eighth of the referrals required a phone call, but in eReferral less than 1 percent needs a call. The paper-based system needs to assign almost 40 percent of referrals as urgent overbook appointments, in eReferral, the urgent overbook rate is only 13.2 percent (for medical departments) or 11.2 percent (for surgical departments). The eReferral reviewers identified 23 percent (medical) or 19.2 percent (surgical) of referral requests that eventually do not require a specialist appointment and thus never result in a scheduled appointment. The eReferral specialty survey showed that eReferral was effective at decreasing preventable followup visits. The iterative communication that eReferral enabled allowed for reviewers to advise referring providers about the optimal previsit evaluation. Thus, the overall proportion of patients needing followup decreased in the specialty clinics. Estimated from survey, the medical specialists experienced a modest increase in the probability of appropriate referral from 67.6 percent to 78.5 percent, while the surgical specialists saw a larger increase in this probability, from 57.8 percent to 88.5 percent. Both groups of specialists experienced reductions in probabilities of premature or unnecessary referrals.

Table 4. Estimates of decision point probabilities (in %), medical and surgical

	Medical departments Paper-based referral	Medical departments eReferral	Surgical departments Paper-based referral	Surgical departments eReferral
Calling specialist to discuss case urgency*	13.7%	0.9%	12.0%	0.8%
Routine appointment†	60.2%		63.1%	
Urgent overbook appointment†	39.8%		36.9%	
Initially scheduled routine appointment‡		53.6%		57.5%
Urgent overbook appointment‡		13.2%		11.2%
Not initially scheduled‡		33.2%		31.3%
Not initially scheduled and scheduled after additional discussion‡		10.2%		12.1%
Not initially scheduled and never scheduled‡		23.0%		19.2%
Specialist deemed appropriate referral§	67.6%	78.5%	57.8%	88.5%
Specialist deemed premature referral§	26.1%	19.1%	32.8%	8.5%
Specialist deemed unnecessary referral§	6.3%	2.4%	9.4%	3.0%

Notes: * Estimated by the study investigators after consulting key informants in clinics. † Estimated by the study investigators after consulting schedulers in SFGH and calibrated by simulation results. ‡ Estimated from eReferral system logs. § Estimated from eReferral specialty survey.

Table 5. Estimates of decision point probabilities (in %) both medical and surgical

Both Medical and Surgical	Paper-based referral	eReferral
Phone required for incoming referral*	50%	
Fax lost*	4%	
Patient show up†	75%	80%
No-show patient return*	50%	50%

Notes: * Estimated by the study investigators after consulting key informants in clinics. † Estimated from eReferral system logs.

Performer Information. Performer information includes properties of every role involved in the systems. The referral process involves many different healthcare personnel. Our models specify six work roles: (1) primary care provider (PCP); (2) medical assistant (MEA) in PCP's clinic; (3) scheduler in specialist clinic; (4) specialist seeing patients in clinic; (5) MEA in specialist clinic; and (6) specialist reviewer. Each task in the model is performed by one or more of these personnel. Their time spent in the referral process constitutes the labor costs in the simulation models. Table 6 lists each role's main responsibility in the referral process, the work setting, average wage (in order to calculate labor costs), and to which system the role applies. Reviewers have a role only in the eReferral system, whereas the other five roles are needed in both systems. The medical departments use specialists as reviewers, whereas the surgical departments use nurse practitioners as reviewers, and thus the hourly wages are dramatically different. Surgeons' hourly wages are one-third higher than medical specialists. All other roles are identical in the different models. The wage information was modified from the 2008 California State wage average in corresponding vocational category (United States Department of Labor, Bureau of Labor Statistics, 2008). Because the primary goal of the simulation is to compare the costs of the systems, the number of performers was assumed to be unconstrained in the process.

Table 6. Task performers in the referral simulation models

Performer	Main responsibility	Working location	Average wage in medical model (/hr)	Average wage in surgical model (/hr)	Needed in electronic referral system?	Needed in traditional referral system?
PCP	See patients and make initial decision whether a specialty referral is needed	PCP clinic	78	78	yes	yes
MEA(PCP)	Assist PCP in dealing with referral process	PCP clinic	39	39	yes	yes
Scheduler	Schedule appointments for specialists	Specialty clinics	24	24	yes	yes
Reviewer	Screen referral requests; send inappropriate referrals back to PCP with co-management advice	Reviewer's office	105	44*	yes	
Specialist	Examine patient, order incomplete testing, proceed to treatment if indicated	Specialty clinics	105	140	yes	yes
MEA(specialist office)	Clinical intake of patients at specialty clinics	Specialty clinics	39	39	yes	yes

*Surgical clinic reviewers are nurse practitioners

Verification of Model

The verification process included confirmation of input parameters and of endogenous logical relationship (i.e., workflow and assumptions) used in the model. For this study, we performed each of the following recommended steps to ensure accurate simulation models (Manuel D, et al., 2000):

1. Data used in the model are empirical data, either based on the SFGH survey results or on expert opinion.
2. We created overall workflow and specific activity flow diagrams of the systems to confirm the inputs and outputs and process steps with a group of system users through successive revisions of the models.
3. We used the empirical data from the SFGH survey to set up test points and verify that the simulation produced data congruent with the observed indicators, such as the time consumption trends provided by the PCPs and the specialists.
4. We inspected animations of the referral process model to check whether the flow of events being simulated and the queuing of patients at various points in the model matched expectations.

Results

We collected the simulation results for number of appointments (Table 7) and net labor needed (Table 8) to care for a fixed base population generating 854 initial medical specialty

referrals and 1212 initial surgical specialty referrals per year. These volumes are from the weighted average of nine medical subspecialties and six surgical subspecialties at SFGH.

Table 7. Simulation results of annual appointments made in medical and surgical departments

Event Type	Medical Departments Paper-based	Medical Departments eReferral	Surgical Departments Paper-based	Surgical Departments eReferral
1. Total new referrals initiated by PCPs annually	854	854	1212	1212
2. Additional submission of referral request due to lost referral fax	39	n/a	56	n/a
3. PCP followup visits to manage issues that the PCP can manage after reviewer deems referral unnecessary, post-eReferral	n/a	223	n/a	164
4. PCP followup visits for further testing requested by reviewer (premature referral) post-eReferral	n/a	97	n/a	412
5. Number of followup appointments at PCP office after no-show at specialist appointment	123	91	174	136
6. Total specialist appointments scheduled	1167	824	1725	1154
6a.Specialist routine appointments scheduled	1159	816	1715	1144
6b.Specialist urgent appointments scheduled	8	8	10	10
7. Total specialist visits with patient no show	256	188	370	275
8. Specialist visits for inappropriate referral	62	23	130	30
8a. Specialist determined inappropriate referral at initial visit	45	13	99	24
8b. Specialist determined inappropriate referral after additional tests	17	10	31	6
9. Specialist visits with inadequate workup (i.e., premature; requires avoidable follow up)	192	102	341	70
10. Specialist deemed productive referral eventually	649	504	874	769
10a. Specialist deemed productive referral at initial visit	494	422	598	712
10b. Specialist deemed productive referral after additional tests	155	82	276	57
11. Total avoidable re-evaluation appointments	172	91	307	63

Table 7 shows the model-predicted differences in appointments resulting from 854 initial medical and 1212 initial surgical referrals. A total of 1167 medical and 1725 surgical specialist appointment slots are filled in the paper-based system. The appointment slots are greater than the number of referral requests because, in addition to scheduling one specialist appointment for each referral request, the extra appointments are due to returning no-show patients and patients needing followup visits when preliminary tests were not done. However, in the eReferral system, as shown in Figure 5, the reviewer will screen out initial referral requests that either do not require a specialist appointment (223 in medical and 164 in surgical), or are premature because additional tests are needed (97 in medical and 412 in surgical). Therefore, the same initial referrals will only require 824 medical and 1154 surgical specialist appointments, a reduction of 29 percent and 33 percent, respectively for medical and for surgical specialist appointment slots used.

Because of the effect of no-show patients, the eReferral system will lead to productivity gain for the specialists by reducing number of no-show from 256 to 188 appointments collectively for medical subspecialties, and from 370 to 275 collectively for surgical subspecialties. For those appointments with patients present, the specialist-deemed inappropriate and premature referrals reduce from 254 (i.e., 62 inappropriate and 192 premature referrals) to 125 (i.e., 23 inappropriate and 102 premature referrals) for medical departments. More dramatically, for surgical departments, such inappropriate and premature referrals reduce from 471 (i.e., 130 inappropriate and 341 premature referrals) to only 100 (i.e., 30 inappropriate and 70 premature referrals).

Thus, the eReferral system creates substantial net reductions in unnecessary uses of specialist visits. The resulting capacity could be used to increase patient access to specialists and reduce wait times for a next available appointment.

However, achieving these savings requires an up-front investment of reviewer time. Tables 8 and 9 are a summary of labor hours and labor costs categorized by job role. "Time consumed" records the labor hours of all the task performers involved in the referring process. The average wage of these positions is then applied to calculated labor costs. "Cost savings" is the difference between the paper-based system and electronic systems.

Table 8. Predicted total labor and labor costs for medical and surgical referrals per year—medical (854 initial referrals)

Operator	Time consumed annually in hours Paper-based	Time consumed annually in hours eReferral	Hourly wage	Annual costs ($) Paper-based	Annual costs ($) eReferral	Cost saving ($) per year
PCP	69.0	187.4	78	5382	14617	-9235
MEA (PCP office)	168.8	0.7	39	6583	27	6557
PCP office subtotal	237.8	188.1		11965	14644	-2679
Specialty clinic Specialist Reviewer	N/A	133.9	105	N/A	14064	-14064
Specialty clinic Scheduler	77.9	34.3	24	1870	823	1047
Specialist	200.2	123.6	105	21021	12978	8043
MEA (specialty clinic)	193.5	137.3	39	7545	5356	2189
Specialty clinic subtotal	471.6	429.2		30436	33221	-2785

*The unit presented in this table is the weighted average volume of referral requests initiated by PCP per specialty department. The costs calculated in this table include all relevant labor costs for referring process. NP = Nurse practitioner.

Table 9. Predicted total labor and labor costs for medical and surgical referrals per year surgical (1212 initial referrals)

Operator	Time consumed annually in hours, Paper-based	Time consumed annually in hours, eReferral	Hourly wage	Annual costs ($) Paper-based	Annual costs ($) eReferral	Cost saving ($) per year
PCP	95.0	252.4	78	7410	19687	-12277
MEA (PCP office)	242.7	0.9	39	9466	36	9430
PCP office subtotal	337.7	253.3		16876	19723	-2847
Specialty clinic NP Reviewer	N/A	163.9	44	N/A	7211	-7211
Specialty clinic Scheduler	114.9	48.3	24	2757	1160	1597
Specialist	287.2	186.3	140	40208	26082	14126
MEA (specialty clinic)	287.8	192.3	39	11226	7501	3725
Specialty clinic subtotal	689.9	590.8		54191	41954	12237

*The unit presented in this table is the weighted average volume of referral requests initiated by PCP per specialty department. The costs calculated in this table include all relevant labor costs for referring process. NP = Nurse practitioner.

We predicted and summarized the subtotal for PCP offices and for specialist departments. The results show that the eReferral system has an opposite economic impact on PCP offices and specialty clinics.

For the PCP offices, compared to the paper-based system, the eReferral system uses less total labor hours (237.8 hours annually in paper-based system vs. 188.1 in eReferral for referring to medical subspecialties, and 337.7 in paper-based vs. 253.3 hours in eReferral for referring to surgical subspecialties). However, because eReferral shifted some work typically done by MEAs to PCPs (e.g., submitting referrals) and because PCPs are more likely to order tests in this system to avoid unnecessary referral or managing premature referrals, there is a higher economic cost to the PCP's office.

From the specialty clinics perspective, in the medical departments, eReferral requires slightly higher labor costs than traditional paper-based referral method does; but for surgical departments, the eReferral system is cost-saving. As shown in Tables 8 and 9, although the eReferral system requires the addition of reviewer time by 134 hours in medical departments and 164 hours in surgical departments annually to triage the referral requests, specialist time spent in seeing referred patients reduces by 76.6 hours (from 200.2 hours to 123.6 hours) for medical subspecialties, and by 100.9 hours (from 287.2 hours to 186.3 hours) for surgical subspecialties. Still, this is a net increase in professional hours of 29 percent in medical and 22 percent in surgical departments. There are additional saved labor hours for MEAs and schedulers from reduced appointments. However, the important cost factor is hourly wage. Surgical departments used nurse practitioners as reviewers, instead of using specialists. Due to their wage difference ($44/hr for nurse practitioners vs. $140/hr for surgeons), this staffing significantly reduces costs in the process of triaging patients compared to using specialists or triaging through patient visits. Thus, this implementation model makes the eReferral system a cost-saving technology (annual saving of $12,237). Medical departments used specialists as reviewers and incurred greater net increases in specialist time (29 percent vs. 22 percent in surgical), resulting in modest net costs for using eReferral (annual cost of $2,785).

Tables 10 to 13 show decompositions of specialist time and of PCP time for medical and for surgical referrals (excluding the time spent by eReferral reviewers, shown in Tables 8 and 9). The results show that, compared to the paper-based system, the eReferral system saves time for specialists to handle the PCP-initiated referral requests (Tables 10 and 11). The

saved time is from the reduction in the number of appointments, not in the time seeing a patient (that is, each patient will still require an average of approximately 12 to 13 minutes for the initial assessment and subsequent avoidable steps). Through the reviewer's triage of the referral requests, the medical specialists' collective time spent reduced from 231 minutes to 143 minutes per week, a savings of 88 minutes per week (40 percent). The decomposition of specialist time for medical referrals is shown in Table 10. The net 76.6-hour reduction in specialist time is valued at $8,049 (reduced from $21,023 in paper-based system to $12,974 in eReferral) annually. Similarly, for surgical specialists (Table 11), their collective time saving of 116 minutes per week (35 percent), or, equivalently, net 100.9-hour annually, is valued at $14,120.

Table 10. Decomposition of specialist time for 854 medical referrals per year

Specialist	Time consumed: paper-based One year (in hours)	Time consumed: paper-based Per week (in min)	Time consumed: paper-based Per referral (in min)*	Time consumed: eReferral One year (in hours)	Time consumed: eReferral Per week (in min)	Time consumed: eReferral Per referral (in min)∓	Cost per year Paper-based	Cost per year eReferral
Initial assess-ment visit	128.5	148.3	8.5	92.2	106.4	8.7	13491.45	9684.15
Consult-ation and workup for avoidable followup visits	28.3	32.6	1.9	15.1	17.4	1.4	2968.35	1580.25
Arranging tests	28.6	33.0	1.9	15.4	17.7	1.5	3001.95	1613.85
Other	14.9	17.2	1.0	0.9	1.1	0.1	1561.35	95.55
sum	200.2	231.0	13.2	123.6	142.6	11.7	21023.10	12973.80

* and ∓ mean the denominators are number of specialist appointments with patient present, i.e., scheduled - no-show visits.

Table 11. Decomposition of specialist time for 1212 surgical referrals per year

Specialist	Time consumed: paper-based One year (in hours)	Time consumed: paper-based Per week (in min)	Time consumed: paper-based Per referral (in min)*	Time consumed: eReferral One year (in hours)	Time consumed: eReferral Per week (in min)	Time consumed: eReferral Per referral (in min)∓	Cost per year Paper-based	Cost per year eReferral
Initial assess-ment visit	167.2	192.9	7.4	164.7	190.0	11.2	23405.2	23056.6
Consult-ation and workup for avoidable followup visits	50.8	58.6	2.2	10.2	11.7	0.7	7110.6	1423.8
Arranging tests	50.9	58.7	2.3	10.1	11.7	0.7	7121.8	1416.8
Other	18.4	21.2	0.8	1.4	1.6	0.1	2569	189
sum	287.2	331.4	12.7	186.3	215.0	12.7	40206.60	26086.20

* and ∓ mean the denominators are number of specialist appointments with patient present, i.e., scheduled - no-show visits.

The decomposition of PCP time (Table 12 for medical referrals and Table 13 for surgical referrals) shows that they need to spend an average of approximately 8 additional minutes for

each initiated referral request as a result of the eReferral system use. Their tasks, including making the initial referral request, ordering clinical workups and tests, and managing follow up care as recommended by the reviewers, etc., are new or intensified in the eReferral system. Some tasks, especially those delegated to MEAs in the paper-based system (e.g. fax and/or call specialist clinic to submit the referral request) are no longer the routine practice in eReferral. Thus, MEAs and schedulers are spending less time for the same amount of the initial referral requests. Overall, eReferrals require somewhat higher labor costs for PCP offices than traditional referral methods ($9,231/year for 854 annual medical referrals, and $12,274/year for 1212 surgical referrals). (If physicians learn to predict inappropriate referrals and not submit them, the labor time and cost of using eReferral might be reduced.)

Table 12. Decomposition of PCP time for 854 medical referrals per year

Specialist	Time consumed: paper-based One year (in hours)	Time consumed: paper-based Per week (in min)	Time consumed: paper-based Per referral (in min)*	Time consumed: eReferral One year (in hours)	Time consumed: eReferral Per week (in min)	Time consumed: eReferral Per referral (in min)∓	Cost per year Paper-based	Cost per year eReferral
Submitting referral	36.4	42.0	2.6	85.9	99.1	6.0	2838.42	6700.98
Ordering tests	0.0	0.0	0.0	46.1	53.2	3.2	0	3595.8
Managing follow up	14.8	17.1	1.0	52.6	60.6	3.7	1154.4	4098.9
Other	17.8	20.6	1.3	2.8	3.3	0.2	1391.52	219.96
sum	69.0	79.7	4.8	187.4	216.2	13.2	5384.34	14615.64

* The denominators are the number of initial medical referrals (i.e., 854).

Table 13. Decomposition of PCP's time for 1212 surgical referrals per year

Specialist	Time consumed: paper-based One year (in hours)	Time consumed: paper-based Per week (in min)	Time consumed: paper-based Per referral (in min)*	Time consumed: eReferral One year (in hours)	Time consumed: eReferral Per week (in min)	Time consumed: eReferral Per referral (in min)∓	Cost per year Paper-based	Cost per year eReferral
Submitting referral	51.5	59.4	2.6	121.9	140.7	6.0	4018.56	9508.98
Ordering tests	0.0	0.0	0.0	61.7	71.2	3.1	0	4812.6
Managing follow up	21.5	24.8	1.1	67.2	77.5	3.3	1677	5241.6
Other	22.0	25.4	1.1	1.6	1.8	0.1	1717.56	124.02
sum	95.0	109.7	4.7	252.4	291.2	12.5	7413.12	19687.20

* The denominators are the number of initial surgical referrals (i.e., 1212).

Discussion

Some points to consider in interpreting the results from the business case modeling exercise include the following:

First, the distinguishing feature of the paper-based and eReferral systems is not merely the use of a new software application. Rather, eReferral involves review and comanagement processes for early triaging of referral requests and information sharing between PCPs and specialists. These attributes in the electronic system result in reduction of inappropriate

referrals and the labor costs associated with them and improvement in timeliness of care. However, because the new processes also require additional labor costs, the use of eReferral may not always be cost saving. The business case for the eReferral system is strongly influenced by the labor rates of the reviewers.

However, despite the finding that eReferral was cost saving only for surgical clinics, another major advantage of eReferral is enhanced communication between PCPs and specialists and reduced wait time for routine appointments (Augestad KM et al., 2008). Although our model did not attempt to quantify those benefits, results of the eReferral logs, specialty surveys, and/or interviews found these effects, and these are additional dimensions of the business case that should be considered in the decision to implement an electronic system.

It is also important to consider that there is a learning curve for use of technologies. eReferral was a relatively new tool that people were learning to use and integrate into their daily work routines at the time of our study. Our data are from practices that had been using eReferral for less than 1 year, so it is possible that after users have more experience with the system and the technical features of the system are improved, further benefits in both financial and quality outcomes have been realized.

In conclusion, eReferral is widely viewed as a success by specialists and referring physicians alike. The system has substantially improved access to specialty care and communication between specialists and referring physicians. Both specialty and referring-physician users perceived any differences in the time needed to for the eReferral process as valuable contributions to patient care. However, our model of the eReferral work process predicted that, on average, the time saved from avoidable appointments and other efficiencies was less than the time required to review the eReferrals. Thus, eReferral was predicted as net cost saving only for clinics in which reviews could be conducted by less-expensive mid-level providers. A limitation is that the work process models have not been prospectively validated, for example, testing whether system design changes result in actual time and cost tradeoffs as predicted by the model. Establishing valid simulation models that can predict the costs and benefits of electronic referral system designs will be important for creating successful electronic referral systems in other settings of care.

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Appendix A. Parameters of the Simulation Models

1. Medicine Departments

Note: Italic texts represent items that are unique for eReferral system; underlined texts represent items that are unique for paper-based system; bold text stands for items that apply to both.

Process information

Activity	Notes: E-referral system	Notes: Paper-based system	Time consumed (min): E-referral system	Time consumed (min): Paper-based system	Performer: E-referral system	Performer: Paper-based system	Data source
Submit referral			**5 ~ 10, use gamma (3,2)**	**2 ~ 3, use gamma (3,0.85)**	**PCP**	**PCP**	**eReferral workflow data v2**
Find fax and phone numbers; fax referral (or vice-versa)				***5~ 15, use gamma (3,3)***		MEA(PCP)	eReferral workflow data v2
Call specialist clinic for the incoming referral		In clinics that require phone notification of coming referral		1		MEA(PCP)	eReferral workflow data v2
Appointment information written on referral form, given to patient				1~2		MEA(PCP)	eReferral workflow data v2
Scheduler receive the referral				1		Scheduler	
Book an appointment for patients			**2~3**	**2~3**	**Scheduler**	**Scheduler**	**eReferral workflow data v2**
PCP reads comment	**For PCP deemed patients whose follow-up could be avoided**	**In follow up (lost fax) cases**	**3~5**	**5~7**	**PCP**		**eReferral workflow data v2**
Reviewer reviews the E referral			*4 ~ 15, use gamma(3, 2)*		*Reviewer*		*eReferral workflow data v2*
PCP arranges clinical workup	*For PCP deemed patients whose follow-up could be avoided*		*5~15, use gamma (3,3)*		*PCP*		*eReferral workflow data v2*
PCP spends additional time manage the patient	*Reviewer deemed inappro-priate referrals*		*3~5*		*PCP*		*From discussion*

Process information (continued)

Activity	Notes: E-referral system	Notes: Paper-based system	Time consumed (min): E-referral system	Time consumed (min): Paper-based system	Performer: E-referral system	Performer: Paper-based system	Data source
MEA time seeing patient in specialist office			**10**	**10**	**MEA (specialist)**	**MEA (specialist)**	
Initial assessment for appropriateness			**2~5, use gamma (3, 0.85)**	**2~5, use gamma (3, 0.85)**	**Specialist**	**Specialist**	**eReferral workflow data v2**
Complete consultation and clinical workup for follow-up that could be avoided	**For specialist deemed patients whose follow-up could be avoided**	**For specialist deemed patients whose follow-up could be avoided**	**7 ~ 17, use 2+gamma (3.3)**	**7 ~ 17, use 2+gamma (3.3)**	**Specialist**	**Specialist**	**eReferral workflow data v2**
Specialist arranges test	**For specialist deemed patients whose follow-up could be avoided**	**For specialist deemed patients whose follow-up could be avoided**	**5~15, use gamma (3.3)**	**5~15, use gamma (3.3)**	**Specialist**	**Specialist**	**eReferral workflow data v2**
PCP follows up with no show patients and resubmit referral	**No show patients**	**No show patients**	**2**	**5**	**PCP**	**PCP**	
PCP fill out the referral again and give it to MEA		In follow up (lost fax) cases		2 ~ 3, use gamma (3,0.85)		PCP	
PCP calls operator get the phone No of specialist	**Urgent cases**	**Urgent cases**	**1~2**	**1~2**	**PCP/ scheduler**	**PCP/ scheduler**	**eReferral workflow data v2**
PCP call and discuss with specialist	**Urgent cases**	**Urgent cases**	**7~8**	**7~8**	**PCP/ specialist**	**PCP/ specialist**	**eReferral workflow data v2**
Call the scheduler or RN to add on to the clinic for a specific date (if fellow/resident do not give you a specific time to relay to the patient)	**Urgent cases**	**Urgent cases**	**3~5**	**3~5**	**MEA(PCP)**	**MEA(PCP)**	**eReferral workflow data v2**
MEA checks appt status two week before appointments	*Urgent cases*		*1~2*		*MEA(PCP)*		
Hand completed form to patient/request referral in LCR, inform them of appointment date/time	**Urgent cases**	**Urgent cases**	**1~2**	**1~2**	**PCP**	**MEA**	**eReferral workflow data v2**

Decision points

Decision point	Percentage: E-referral system	Percentage: Paper-based system	Data source: E-referral system	Data source: Paper-based system
Non urgent rate	**99.1%**	**86.3%**	**Discussion**	**Discussion**
Routine book rate	*53.6%*	*Initial booked*	*60.200%*	
Overbook rate	*13.2%*	*Never scheduled*	*39.800%*	
Not initially scheduled	*33.2%*			
Scheduled after additional discussion	*30.6%*			
Never scheduled after discussion	*69.4%*			
Percentage of specialist deemed appropriate referral	**78.5%**	**67.6%**	**eReferral Specialty survey manuscript ac-db.doc**	**eReferral Specialty survey manuscript ac-db.doc**
Percentage of specialist deemed premature referral	**19.1%**	**26.1%**	**eReferral Specialty survey manuscript ac-db.doc**	**eReferral Specialty survey manuscript ac-db.doc**
Percentage of specialist deemed unnecessary referral	**2.4%**	**6.3 %**	**eReferral Specialty survey manuscript ac-db.doc**	**eReferral Specialty survey manuscript ac-db.doc**
Patient show up rate	**80%**	**75%**	**eReferral workflow data v2**	**eReferral workflow data v2**
Percentage of no show patients coming back	**50%**	**50%**		
Whether phone call required for incoming referral (MEA task)		50%		
Whether fax was successfully received		96%		

2. Surgical Departments

Note: Italic texts represent items that are unique for eReferral system; underlined texts represent items that are unique for paper-based system; bold text stands for items that apply to both.

Process information

Activity	Notes: E-referral system	Notes: Paper-based system	Time consumed (min): E-referral system	Time consumed (min): Paper-based system	Performer: E-referral system	Performer: Paper-based system	Data source
Submit referral			5 ~ 10, use gamma (3,2)	2 ~ 3, use gamma (3,0.85)	PCP	PCP	eReferral workflow data v2
Find fax and phone numbers; Call clinic then fax referral (or vice-versa)				*5~ 15, use gamma (3,3)*		MEA(PCP)	eReferral workflow data v2
Call specialist clinic for the incoming referral		In clinics that require phone notification of coming referral		1		MEA(PCP)	eReferral workflow data v2
Appointment information written on referral form, given to patient				1~2		MEA(PCP)	eReferral workflow data v2
Scheduler receive the referral				1		Scheduler	
Book an appointment for patients			**2~3**	**2~3**	**Scheduler**	**Scheduler**	**eReferral workflow data v2**
Reviewer reviews the E referral			*3 ~ 7*		*Reviewer*		*eReferral workflow data v2*
PCP reads comment	*For PCP deemed patients whose follow-up could be avoided*		*3~5*		*PCP*		*eReferral workflow data v2*
PCP arranges clinical workup	*For PCP deemed patients whose follow-up could be avoided*		*5~15, use gamma (3,3)*		*PCP*		*eReferral workflow data v2*
PCP spends additional time manage the patient	*Reviewer deemed inappro-priate referrals*		*3~5*		*PCP*		*From discussion*

Process information (continued)

Activity	Notes: E-referral system	Notes: Paper-based system	Time consumed (min): E-referral system	Time consumed (min): Paper-based system	Performer: E-referral system	Performer: Paper-based system	Data source
MEA time seeing patient in specialist office			**10**	**10**	**MEA (specialist)**	**MEA (specialist)**	
Initial assessment for appropriateness			**2~5, use gamma (3, 0.85)**	**2~5, use gamma (3, 0.85)**	**Specialist**	**Specialist**	**eReferral workflow data v2**
Complete consultation and clinical workup for follow-up that could be avoided	**For specialist deemed patients whose follow-up could be avoided**	**For specialist deemed patients whose follow-up could be avoided**	**7 ~ 17, use 2+gamma (3.3)**	**7 ~ 17, use 2+gamma (3.3)**	**Specialist**	**Specialist**	**eReferral workflow data v2**
Specialist arranges test	**For specialist deemed patients whose follow-up could be avoided**	**For specialist deemed patients whose follow-up could be avoided**	**5~15, use gamma (3.3)**	**5~15, use gamma (3.3)**	**Specialist**	**Specialist**	**eReferral workflow data v2**
PCP follows up with no show patients and resubmit referral	**No show patients**	**No show patients**	**2**	**5**	**PCP**	**PCP**	
PCP checks the case		In follow up (lost fax) cases		5~7		PCP	
PCP fills out the referral again and give it to MEA		In follow up (lost fax) cases		2 ~ 3, use gamma (3,0.85)		PCP	
PCP calls operator get the phone No of specialist	**Urgent cases**	**Urgent cases**	**1~2**	**1~2**	**PCP/ scheduler**	**PCP/ scheduler**	**eReferral workflow data v2**
PCP call and discuss with specialist	**Urgent cases**	**Urgent cases**	**7~8**	**7~8**	**PCP/ specialist**	**PCP/ specialist**	**eReferral workflow data v2**
Call the scheduler or RN to add on to the clinic for a specific date (if fellow/resident do not give you a specific time to relay to the patient)	**Urgent cases**	**Urgent cases**	**3~5**	**3~5**	**MEA(PCP)**	**MEA(PCP)**	**eReferral workflow data v2**
Hand completed form to patient/request referral in LCR, inform them of appointment date/time	**Urgent cases**	**Urgent cases**	**1~2**	**1~2**	**PCP**	**MEA**	**eReferral workflow data v2**

Decision points

Decision point	Percentage: E-referral system	Percentage: Paper-based system	Data source: E-referral system	Data source: Paper-based system
Non urgent rate	**99.2%**	**88.0%**	**Discussion**	**Discussion**
Routine book rate	*57.5%*	*Initial booked*	*63.100%*	
Overbook rate	*11.2%*	*Never scheduled*	*36.900%*	
Not initially scheduled	*31.3%*			
Scheduled after additional discussion	*38.8%*			
Never scheduled after discussion	*61.2%*			
Percentage of specialist deemed appropriate referral	**88.5%**	**57.8%**	**eReferral Specialty survey manuscript ac-db.doc**	**eReferral Specialty survey manuscript ac-db.doc**
Percentage of specialist deemed premature referral	**8.5%**	**32.8%**	**eReferral Specialty survey manuscript ac-db.doc**	**eReferral Specialty survey manuscript ac-db.doc**
Percentage of specialist deemed unnecessary referral	**3.0%**	**9.4 %**	**eReferral Specialty survey manuscript ac-db.doc**	**eReferral Specialty survey manuscript ac-db.doc**
Patient show up rate	**80%**	**75%**	**eReferral workflow data v2**	**eReferral workflow data v2**
Percentage of no show patients coming back	**50%**	**50%**		
Whether phone call required for incoming referral (MEA task)		50%		
Whether fax was successfully received		96%		