Implementing Health Information Technology to Improve the Process of Health Care Delivery: A Case Study

MARILYN FOLLEN, R.N., M.S.N.,1 RACHEL CASTANEDA, Ph.D.,2,3
MELISSA MIKELSON, R.N., B.S.N.,1 DEBRAH JOHNSON, R.N., B.S.N.,1
ALISA WILSON, Ph.D.,2 KEIKO HIGUCHI, M.P.H.2

ABSTRACT
Integration of health information is critical to the provision of effective, quality care in today’s fragmented health care system. The increasing prevalence of chronic conditions and the demand for a comprehensive understanding of patient health on the part of providers are driving the need for the integration of health information through electronic health information systems. Two distinct health information systems currently utilized in the health care field include electronic medical records (EMR) and chronic disease management systems (CDMS). The integration of these systems is likely to enable the efficient management of health information and improve the quality of health care as it would provide real-time patient information in a coordinated manner. The lack of real-time information may result in delayed treatment, uninformed decisions, inefficient resource use, and medical errors. Despite their importance and widespread support, these systems have slow provider adoption rates. Our understanding of how health information technology may be used to improve health care is limited by the relative paucity of research on the adoption, integration, and implementation of these 2 types of systems. This paper documents the use of an EMR at Marshfield Clinic, a multidisciplinary group practice in the United States. We review the concomitant use of an EMR for clinical data capture and the implementation of a proprietary CDMS, InformaCare®, for care management of chronic diseases. These 2 systems allow providers to deliver health care using evidence-based guidelines that meet the Institute of Medicine’s aim of providing safe, efficient, patient-centered, and timely care. (Disease Management 2007;10:208–215)

INTRODUCTION
The delivery of health care in the United States is under intense scrutiny due to the fragmented way in which care is delivered and reimbursed. Policy makers have suggested that the integration of patient information from disparate sources using health information systems may improve both the delivery and quality of patient care. Results of a survey of key opinion leaders indicates that increased use of information technology to improve the quality and safety of care is one of their 3 highest priorities.1 The Institute of Medicine also has cited the use

1Marshfield Clinic, Marshfield, Wisconsin.
2Pfizer Health Solutions Inc, Santa Monica, California.
3Department of Medicine, University of California Los Angeles, California.
of health information technology systems as an important quality improvement tool.\textsuperscript{2,3}

The way in which most patient records are stored contributes to the fragmented delivery of health care. The majority of medical information is still recorded on paper, making it challenging to efficiently coordinate care, effectively measure quality, or reduce medical errors in a manner that is not labor intensive.\textsuperscript{4} The costs associated with system inefficiencies and associated medical errors are estimated to be as much as $29 billion annually.\textsuperscript{5} The broad adoption of health information technology systems within the US health care system has been proposed as a strategy to simultaneously reduce medical errors, increase quality of care, and save the health care system billions of dollars annually.\textsuperscript{3,4}

Given the potential advantages of using an electronic infrastructure for patient care, the time for the adoption and use of health information systems for quality care improvement has come.\textsuperscript{6} Despite the various benefits of health information technology systems, there has been relatively little systematic study of their adoption or utilization. This paper examines the implementation and use of an electronic medical record (EMR) and chronic disease management system (CDMS) at Marshfield Clinic and how these systems are used to facilitate and enhance patient care and provider satisfaction. A patient scenario is presented as an example of how health care providers actually use and work with these 2 health information systems at the Marshfield Clinic. Policy implications for implementing health information technology systems are discussed relative to how their adoption and integration can affect the delivery of coordinated health care and improve patient outcomes.

HEALTH INFORMATION TECHNOLOGY SYSTEMS

The health information technology system currently generating the most interest is the EMR.\textsuperscript{7,8,9} Operating as a clinical data repository or warehouse,\textsuperscript{10} the EMR provides access to real-time patient-level medical information, often through a Web-based interface.

EMR systems have wide-ranging potential for enhancing patient care and decreasing medical errors. Empirical evidence suggests that implementation of an EMR can offer multiple benefits. Their use can facilitate the provision of evidence-based decision support for providers to manage patients in a timely and systematic way.\textsuperscript{11,12,13} EMRs may also facilitate complete electronic documentation and efficient sharing of patient information across multiple providers, document medications prescribed, and laboratory tests ordered and performed. In addition, some systems allow pharmacists the ability to dispense medications as well as check for drug-drug interactions, allowing providers and pharmacists to work more collaboratively to ensure that patients receive adequate information about their medications. EMRs also may be used to order laboratory tests, which should obviate duplicate or unnecessary testing. Each of these EMR functions contributes to the efficiency with which patient information is managed\textsuperscript{14} as well as the quality of care provided. Not only do EMRs lead to cost and time resource benefits for health care providers, but their use has also led to an estimated cost savings of $23 billion for Medicare and $31 billion for private payers annually.\textsuperscript{13} These cost savings are attributable to the accumulation of electronic data, the reduction in staff time used to locate, pull, and file patient medical records, and a decrease in the duplication of tests and services.\textsuperscript{15}

The CDMS is another useful health information technology tool available to health care providers. Unlike EMRs that provide real-time, point-of-care patient information, CDMSs were developed as electronic tools to enhance how health care providers manage patients with 1 or more chronic conditions.\textsuperscript{16} These computer-guided programs have been shown to improve the quality of health care by providing clinical support grounded in evidence-based medicine.\textsuperscript{17} Several CDMSs include tools for disease risk stratification accompanied by disease-specific guidelines and protocols for effective care management.\textsuperscript{16}

Providing technology-based feedback to providers about patients with multiple chronic diseases is an effective means of improving adherence to guideline recommendations and en-
hancing total care management.\textsuperscript{18} Studies focused on improving care for hypertension\textsuperscript{19} and diabetes\textsuperscript{20,21} for example, documented that CDMSs are effective disease management (DM) tools that facilitate reductions in disease-specific symptoms and increase improved health behaviors. Given that care for patients with chronic diseases absorbs more than 75\% of the nation’s health care dollars,\textsuperscript{22} CDMSs should be considered important for improving care for patients with chronic conditions.

\section*{UTILIZATION AND INTEGRATION OF HEALTH INFORMATION TECHNOLOGY AT THE MARSHFIELD CLINIC}

The Marshfield Clinic in Wisconsin is one of the largest private, multispecialty health delivery systems in the United States. The clinic employs over 730 physicians in 80 medical specialties and subspecialties.\textsuperscript{23} The clinic has been using an internally developed EMR system for more than 20 years. Since December 2004 it also has been using a commercially available CDMS product (InformaCare\textsuperscript{®}) to collect and manage patient information as part of its DM and Community Health Access programs. Marshfield Clinic employs 11 full-time nurse care managers (at a state average of $54,527, plus benefits for each nurse) and 2 nurse supervisors for their DM program and Community Health Access programs.\textsuperscript{24} These programs are also supported by 1 data manager, 1 data analyst, and 2 health service coordinators.\textsuperscript{25} To date, over 1000 patients have been managed by nurse care managers who use these 2 systems.\textsuperscript{26}

\subsection*{Marshfield’s EMR system}

The EMR system used at the Marshfield Clinic was developed in the late 1960s in response to the growing volume of patients served. The clinic implemented the EMR to provide access to large volumes of clinical and administrative data for a single patient with a fast response time, to reduce administrative and patient costs, and to improve patient care by minimizing duplication of services while promoting integration of care across specialties. Currently, the EMR system is accessed by Marshfield physicians, nonphysician providers, pharmacists, nurses, care managers, and social workers, as well as cooperating hospitals. It contains indexes to all “events” that patients have encountered while enrolled at Marshfield, as well as text documentation including office notes, operative reports, discharge summaries, and patient problem lists and alerts.

There are several specific elements of this particular EMR, such as a Medication Manager and a Dashboard, that are useful provider tools for tracking and monitoring patient health information. For instance, the Medication Manager and the Dashboard issue reminders or prompts to providers at the point of care (eg, patient is due for a laboratory test, mammogram, or other scheduled service). The EMR facilitates the coordination of information across multiple health care applications, including appointment and medical record tracking, laboratory, radiology, and pharmacy data, and clinical documentation of health status (eg, transcription services, immunization tracking, data interfaces with hospitals and laboratories).

\subsection*{The CDMS}

The Marshfield Clinic uses InformaCare,\textsuperscript{®} a proprietary DM system developed by Pfizer Health Solutions Inc (Santa Monica, CA). InformaCare was specifically designed to aid care managers with clinical decision making tools for patients with chronic disease. At the Marshfield Clinic, InformaCare is exclusively used by the nurse care managers responsible for managing patients enrolled in telephonic DM programs. It serves as a patient data registry that stores clinical and behavioral disease-related information such as telephonic call schedules, tasks, and a patient problem list. It also offers a medication database and decision-making support for care managers via system alerts, feedback, and a variety of online documents, including a care manager guide with recommendations and strategies for achieving patient care goals.

InformaCare facilitates care manager interaction with the provider as the care manager communicates the information received from InformaCare to Marshfield Clinic providers. Similarly, care managers have access to patient
information via the Marshfield EMR to meet the individualized needs of the patient population they care for with clinical support from InformaCare.

Both the EMR and the CDMS have benefits for Marshfield Clinic patients. The adoption and integration of these systems has significantly revolutionized the delivery of health care by providing real-time access to patient data that is readily accessible to the care managers via Marshfield Clinic desktop applications. Because they are supported by sophisticated technology, care managers are able to move between system applications without redundant entry of patient information. InformaCare has facilitated care planning for patients with multiple chronic conditions and has assisted with the coordination and communication of patient health between providers. Marshfield Clinic values the 2 systems for their potential to increase patient safety, offer flexibility, and provide comprehensive patient data that support patient care.

Provider satisfaction surveys were used to evaluate the impact of care management using the health information technology systems in the Marshfield Clinic. Satisfaction outcomes about the utilization of health information technology systems and care management provide useful information about the barriers and successes of adoption. Such data can also be used to improve quality of care. With a response rate of 32%, there was high provider satisfaction with care management as supported by the health information technology systems as 67% of providers “strongly agreed or agreed” it was very helpful. According to the providers, such services improved the quality of care (50%) and patient satisfaction (33%), as well as operational efficiencies by saving provider time (22%) and staff time (26%). Table 1 presents other provider responses demonstrating high satisfaction.27

INTEGRATING PATIENT HEALTH INFORMATION: A PATIENT SCENARIO

To illustrate how the EMR and the CDMS are currently used at Marshfield Clinic, consider the following patient care scenario.

Mr. P, a 67-year-old male diagnosed with congestive heart failure, was discharged from

<table>
<thead>
<tr>
<th>Table 1. Provider Satisfaction Survey Results (n = 46)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>The service has improved the self-care behaviors of my patients and their families.</td>
</tr>
<tr>
<td>The team communicates with me/my team at clinically appropriate times and in an appropriate situation-specific format (ie, telephone, EMR, email).</td>
</tr>
<tr>
<td>The service improves both my practice efficiency and my patients’ clinical outcomes.</td>
</tr>
<tr>
<td>The service is helpful to me/my staff in managing my patients.</td>
</tr>
</tbody>
</table>
an affiliated Marshfield Clinic hospital. Mr. P’s inpatient admission and discharge documents were entered directly into Marshfield’s EMR system upon hospital discharge. These documents contain important medical and care planning information such as the discharge disposition, scheduled follow-up appointments, provider consults, pharmacy prescriptions, and rehabilitation care that has been ordered and/or completed. Upon learning about Mr. P’s hospitalization, his care manager, Ms. C, accessed InformaCare from her desktop to create a task to remind her to contact Mr. P about his post-hospitalization follow-up. Prior to contacting Mr. P, she also used her desktop to access his records in the EMR Dashboard, a user-friendly “executive summary” of important patient information, such as diagnoses, clinical problems, medications, laboratory data, as well as future and past medical appointments.

Ms. C reviewed the Dashboard, which includes diagnosis, medications prescribed, preventive measures met, medical history, diastolic dysfunction, and any past problems. She learned that Mr. P experienced fluid imbalance and required frequent adjustments to his medication regimen. She also reviewed the InformaCare “Contacts” section to find out when a care manager last spoke with him and learned that a care manager last spoke with Mr. P approximately 1 month before his recent hospitalization.

Ms. C accessed InformaCare to review DM program notes and accessed the EMR for any office notes regarding Mr. P’s current medical status. The office notes are crucial as they contain the physician’s assessment, care plan, and medication regime. From her review of what the pharmacist and social worker entered in the EMR, she learned that Mr. P, for financial reasons, was often non-adherent to his medication regimen. She also learned that he had a recent appointment with his cardiologist and that another follow-up appointment was scheduled for the next month. Ms. C identified an opportunity for reinforcing with Mr. P the importance of keeping his appointment. From the office notes in the EMR, she also reviewed his laboratory test results and chest X-ray. She learned from the EMR that he recently received a cardiac pacemaker that is monitored telephonically. If necessary, she can access pacemaker monitoring reports and directly connect to the cardiology department to report any problems he may be experiencing. Ms. C also used the EMR to review Mr. P’s medication discharge list with the information contained in the EMR’s Medications Manager.

Upon completion of her review of Mr. P’s clinical information stored in the EMR and InformaCare, she called him. While on the phone, she assessed his functional status and whether or not he understood the medication regimen prescribed to him at discharge. After learning that Mr. P did not fill his prescriptions due to financial concerns, she made an online referral to a social worker in Marshfield Clinic’s Community Health Resources, a program that assists Marshfield patients with finding resources to cover medication costs or transportation issues. Using InformaCare, Ms. C administered a heart failure questionnaire and updated Mr. P’s Care Plan to reflect that he has difficulty breathing in the afternoon at times. She also created a follow-up task for this problem in InformaCare and added a note in the EMR for his physician, pharmacist, and social worker to review relative to his medication noncompliance due to financial concerns.

Ms. C noticed that Mr. P did not complete any advance directive documents and asked him about planning this part of his future care; she updated InformaCare with this new information. She then reviewed the EMR’s PreServ module. The PreServ module provides an “at-a-glance” summary of the patient’s current status in obtaining preventive care. Ms. C learned that Mr. P was overdue for a colonoscopy referral and offered to contact his provider; she flagged this as a task to complete in InformaCare.

At the conclusion of the call, Ms. C asked Mr. P if he had any questions or concerns. He told her that he did not remember his physician’s earlier instructions regarding his ability to drive, whether he could safely drive alone or required someone to drive for him. She accessed the physician notes in the EMR and read it aloud to him; the note stated “the patient can drive by himself now.” Mr. P conveyed that he was very pleased with the fact that Ms. C was able to access his medical information in “real time” and indicated that he would call Ms. C if he had any questions about his physician in-
Implementing Health Information Technology

Instructions after his upcoming scheduled office visit.

As illustrated in this patient scenario, the 2 health information technology systems are integrated as they assist care managers trained in telephonic DM programs to facilitate information sharing about a patient’s health status and treatment with the entire health care team. This integration provides a richer understanding of the complex functional status of a patient from all perspectives—health, clinical, behavioral, and psychosocial—than would otherwise be possible without expending considerable time and effort in a paper-based system.

**CONCLUSION**

The impetus for this paper was to develop a better understanding of how the use of 2 distinct health information technology systems can be adapted by a large, multispecialty health care system to potentially improve the overall efficiency and quality of care. It illustrates that the EMR and CDMS are 2 useful tools for monitoring clinical and behavioral data as well as chronic disease symptoms. Together, the EMR and CDMS allow care managers to more seamlessly work together with other members of the health care team to customize care management programs for patients. Understanding how Marshfield Clinic implemented its EMR and CDMS systems and the benefits it has achieved by using these 2 applications may help facilitate adoption of similar health information technology in other health care settings.

There were some important operational issues that arose among the providers and care managers during the beginning phases of the implementation of these 2 health information technology systems. A few providers wanted to maintain their previous clinical management styles. Persistent communication and education regarding the importance of the integration of the EMR and CDMS systems was used to address this barrier to adoption. Communications specifically addressed how the 2 tools worked together to incorporate clinical and behavioral information that would ultimately increase the quality of patient care and improve patient safety. As a result, in less than 1 year after implementation, most providers embraced the new care management system supported by EMR and CDMS, as evidenced by the results from the provider satisfaction survey. Lack of awareness among care managers about how to use the 2 new systems was another barrier to the effective implementation of the EMR and CDMS. As a result, systematic care manager training was employed to ensure that there was a common understanding of the data most appropriate for each system to prevent duplicative data collection. With ample training on a standardized process flow and data collection, care managers were able to utilize the best features in the 2 systems effectively.

Despite the successful implementation and integration of the EMR and CDMS at Marshfield Clinic, one limitation is that the EMR and the CDMS are not electronically linked. Currently there is evaluation of data to test the effect of these systems on patient health outcomes. Based on the patient scenario, we can only infer that implementing these 2 health information technology systems within care management programs may improve the process of care, ensure patient safety, and reduce health care costs. Because chronic illnesses within the US population are burdening an already overtaxed health care system, we believe that these 2 systems can be instrumental in alleviating current system inefficiencies. Not only can EMR systems help ensure consistent documentation and timely monitoring of disease-specific clinical measures, but CDMS systems can also help coordinate workflows and communication among providers as well as provide clinical support and education to patients, thereby leading to better health outcomes. Clearly, data are urgently needed to evaluate the real-world application of these systems in terms of accurately gauging their relative effectiveness in promoting positive outcomes. An evaluation by Marshfield Clinic is currently under way to collect patient clinical and behavioral data to test the effect of these systems on patient health outcomes. The metrics that will be used to measure the impact of the integration of the 2 electronic health information technology systems will be based on empirical clinical guidelines in preventive care and disease-specific care. For example, using electronic data from the 2 systems, the Marsh-
field Clinic will assess rates of completed annual influenza vaccinations, annual physical examinations, and all-important quality of care measures. Disease-specific metrics also will be examined, such as changes in medication adherence among heart failure patients using ACE-inhibitors or angiotensin receptor blockers and hemoglobin A1c values among patients with diabetes. In addition, comorbid conditions among the patient population will be assessed (eg, the number of patients screened for depression).

From a health care policy perspective, given the tremendous benefit of health information technology systems in applied health care settings, more widespread efforts aimed at increasing utilization and adoption rates are warranted. The government in particular plays an important role in overseeing this process, as the adoption of these systems may depend on powerful financial incentives, such as pay for performance, that will reward organizations for using such systems and motivate policies that provide these systems to small provider groups at an affordable price.28 Political attention to EMRs and health care information technology is evidenced by the bipartisan support and unanimous passage of the Wired for Healthcare Quality Act (S.1418) in the US Senate that includes federal funding in the form of grants for health information technology adoption.29 Financing alone, however, will not fully address the other barriers that challenge the transition from paper-based methods to the adoption of health information technology systems.

Although more health organizations are adopting pay-for-performance approaches to provide incentives for providers to improve patient care, rigorous analyses on the impact of pay for performance are few.30 A study comparing preventive care outcomes in a pay-for-performance program addressing diabetes care in PacifiCare Health Systems resulted in a significant difference in quality of care between participants and non-participants.31 Additionally, Physician Group Practice (PGP) Demonstration projects, where select physician group practices are charged with investing in process improvements to improve patient care quality through a pay-for-performance initiative, are focusing on expanded data systems, care management programs, and coordination of care efforts to improve patient care.32 Continuing research into pay for performance is necessary to identify specific external factors, such as how pay for performance works in organizations with varying information technology capabilities, that can differentially affect pay-for-performance benefits and outcomes.

While an increasing number of large health systems are considering the adoption of health information technology systems to improve health care quality, the actual adoption rate of EMRs in the United States is slow and not widespread, with only about 15% to 20% of solo-practice physician offices and 20% to 25% of hospitals adopting such systems.36 Common barriers to adoption include resistance by health care providers and health systems because of high implementation costs with no return on investment to the provider, suboptimal design of products and user interfaces, maintenance of the validity and confidentiality of data, uncertainties regarding interoperability standards, and inadequate technical support.37 The key to the future, we believe, is to create a more supportive environment in which interested health care parties work together to address these common and formidably challenging issues.

REFERENCES


Address reprint requests to:
Keiko Higuchi, MPH
1125 Royal Lane
San Carlos, CA 94070

E-mail: khiguchi2000@yahoo.com