■ COMMENTARY

# Transforming Care Delivery through Health Information Technology

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## Abstract

The slow but progressive adoption of health information technology (IT) nationwide promises to usher in a new era in health care. Electronic health record systems provide a complete patient record at the point of care and can help to alleviate some of the challenges of a fragmented delivery system, such as drug-drug interactions. Moreover, health IT promotes evidence-based practice by identifying gaps in recommended treatment and providing clinical decision-support tools. In addition, the data collected through digital records can be used to monitor patient outcomes and identify potential improvements in care protocols. Kaiser Permanente continues to advance its capability in each of these areas.

## Introduction

As one of the nation's earliest adopters of electronic health records (EHRs), Kaiser Permanente (KP) has achieved system-wide use and meaningful integration of health information technology (IT). Health-Connect, the organization's EHR system, was fully completed in 2010 and is now the largest nongovernmental EHR system in the world.[1] KP sees the transition from paper to electronic records as an opportunity for the US health care system overall to become smarter and less fragmented.[2]

KP HealthConnect is a comprehensive EHR system that includes both hospital and medical office data, as well as "circle of support" systems, including pharmacy, laboratory, and digital radiology. In addition, KP offers an online patient portal, My Health Manager (at kp.org), that allows members to e-mail their clinicians via secure messaging, to schedule appointments, to view test results, to refill prescriptions, and to access health education information.[3]

With membership nearing 9 million people, KP's transition to EHRs required a major organizational commitment, hard work and teamwork, and a substantial investment of resources. KP leaders believed strongly that moving to EHRs would result in major improvements in care quality and efficiency. Specifically, the organization anticipated that use of the EHR system would result in improved clinical decision making, better care coordination, reduced medication errors, and new levels of patient engagement, including online

communications. In this article, we explore several aspects of care transformation that are possible through electronic data systems, including more reliable delivery of high-quality evidence-based care, and ongoing care improvements enabled by systematic tracking of patient outcomes.

KP's successful launch of HealthConnect was aided by its structure as an integrated delivery and financing system. The integrated model was instrumental in promoting internal dialogue, achieving alignment of incentives, and eventually adopting a comprehensive health IT system. As we move forward, the shared goals of the Kaiser Foundation Health Plan, Kaiser Foundation Hospitals, and the Permanente Medical Groups will continue to promote improvements in care delivery across the organization.

## Historical Overview

For most of US history, medical care has been carried out by physicians in solo practice relying on paper-based record keeping. As medical care evolved to include more specialists and alternate care sites, gaps in data sharing and communication grew. The often-illegible prescriptions written by physicians were emblematic of the problem. Another outgrowth was wasteful and duplicative patient testing, reflecting the fact that test results from one care location were often not available in another.[4]

In inpatient hospitals across the country, the lack of systematized information sharing and care coordination became evident each

time a patient or family member was required to repeat the same information for new caregivers.[5] Meanwhile, Emergency Department personnel in the US have worked in a relative data vacuum, often treating emergent cases without having information about the patient's medical history.[6]

Within medical research, the volume of literature escalated dramatically over the latter part of the 20th century.[7] From 1978 to 1985, the number of published randomized controlled trials (RCTs) added to the MEDLINE database of medical literature averaged 5000 per year; by 2001, that number had reached 25,000 per year. The new studies shed light on treatment efficacy but also challenged physicians in trying to keep pace with a rapidly expanding, often conflicting, base of knowledge. The Institute of Medicine has asserted that "clinicians increasingly are barraged with a vast volume of evidence of uncertain value."[8]

Research syntheses have become more ubiquitous over time. Organizations conduct systematic reviews of the literature in particular clinical areas, and professional associations and other groups translate the findings into clinical guidelines. These efforts have helped to guide practice but have also added to the flood of information. For example, the National Guideline Clearinghouse now lists 527 guidelines under the category of "hypertension."[9]

### The Quality Chasm

Perhaps not surprisingly, a central criticism of the US health care system for many decades has been its high variability and inconsistency.[10,11] In the late 1990s, the President's Advisory Commission on Consumer Protection and Quality in the Health Care Industry found that "in America there is no guarantee that any individual will receive high-quality care for any particular health problem. The health care industry is plagued with overutilization of services, underutilization of services, and errors in health care practice."[12]

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The Institute of Medicine's Quality Chasm report stated in 2001 that: "Americans should be able to count on receiving care that meets their needs and is based on the best scientific knowledge. Yet there is strong evidence that this frequently is not the case."[13] In 2003, McGlynn et al quantified many of the quality deficiencies in the health care delivery system. Evaluating quality measures for 30 acute and chronic conditions, the authors found that patients received recommended care only 54.9% of the time.[14]

## Advancing Health Information Technology

In addition to providing a complete patient record at the point of care, health IT provides a mechanism for promoting greater reliability in care quality. For example, health IT has a role in identifying and communicating gaps in care—treatments that are recommended for the patient but not yet provided. Health IT can also advance our understanding of effective care by facilitating the aggregation of patient outcomes data.

In 2004, as deployment of IT in various sectors of the US economy was advancing, the Bush administration signed two Executive Orders that launched an effort to promote the adoption of EHRs nationwide. In a strategy document titled Transforming Health Care: The President's Health Information Technology Plan, the administration observed "our doctors and nurses have to manage 21st century medical technology and complex medical information with 19th century tools."[15] The plan sought to ensure that most Americans would have EHRs within 10 years, although it did not allocate federal funding to reach that goal.

The Congressional Budget Office (CBO) concluded in 2008 that health IT "has the potential to significantly increase the efficiency of the health sector by helping providers manage information." The CBO said, the technology can "improve the quality of health care and, ultimately, the outcomes of that care for patients."[16]

## Meaningful Use

As part of the American Recovery and Reinvestment Act of 2009,[17] the Obama Administration's economic stimulus package, the federal government allocated $27 bil-lion over 10 years to promote the adoption and use of EHRs by the nation's providers.[a] Financial incentives were made available to eligible providers meeting a set of specific criteria for the "meaningful use" of such technology. The law included 5 years of financial incentives, up to a maximum of $44,000 per Medicare-eligible professional and $63,750 per Medicaid-eligible professional, plus 4 years of incentives for eligible hospitals.[18] However, beginning in 2015, the carrot becomes a stick for Medicare providers: Medicare reimbursements will be adjusted downwards for those who do not demonstrate meaningful use of certified EHR technology.

In 2010, the US Department of Health and Human Services released the EHR Incentive Program and Certification Standards governing Stage 1 of the meaningful use program.[19,20] The final regulations governing Stage 2 meaningful use were published in September 2012.[21]

The Stage 1 regulations included some of the basic requirements essential for creating any medical record—for example, the ability to record patient demographic information and vital signs, up-to-date problem lists (current and active diagnoses), current medications and allergies, and smoking status. According to the National Coordinator for Health IT at that time, other components of the regulation did "begin to realize the true potential of EHRs to improve the safety, quality, and efficiency of care. These features help clinicians to make better clinical decisions—and avoid preventable errors. To qualify for incentive payments, clinicians must start employing such clinical decision-support tools."[22]

The Stage 2 regulations relating to quality of care seek to align the incentives for using EHRs with the key priorities of the National Quality Strategy (a component of the 2010 federal health reform law).[23] "Specifically, Stage 2 meaningful use criteria encourage the use of health IT for continuous quality improvement at the point of care."[21] Linking to previous efforts to increase the consistency of US health care, the National Quality Strategy states: "over time, our goal is to ensure that all patients receive the right care, at the right time, in the right setting, every time."[24] Health IT is viewed as an enabler in this transformation.

The Stage 3 meaningful use regulations, which are scheduled for release in mid-2013, are expected to emphasize improved clinical decision support.[25]

## Three Steps in Care Transformation

A central aim of the federal government in promoting EHRs nationwide is to establish greater connectivity across care providers. Health care systems such as KP have achieved greater levels of functional cohesion by integrating the components of care—physicians and other care personnel, hospitals and other care sites, and the insurance function—all within the same organization. Even within that integrated structure, however, the transition from paper to EHRs offered a tremendous opportunity to improve communication, data sharing, and clinical decision making.[26]

Health IT can contribute to care transformation in three important ways:
1. *Accessible patient information.* Health IT makes accurate, complete, and up-to-date patient information more accessible to clinicians at the point of care. Additionally, electronic data systems have the potential to improve provider communication, establish better care coordination, and ensure more successful patient transitions.
2. *Better clinical guidance.* In areas where there is consensus regarding optimally effective care, health IT can aid in disseminating known best practices. Through the use of clinical decision-support tools, alerts, or other communication devices, health IT can enhance efforts to reduce gaps in care. This guidance helps ensure reliability in delivering high-quality evidence-based care and can reduce unwarranted variation in practice.
3. *Continuous learning and improvement.* In areas where there are gaps in the knowledge base, or a lack of consensus regarding appropriate treatment protocols, health IT has the potential to support continuous learning and care improvement. Electronic data systems can link treatment selection with observed patient outcomes, providing feedback for clinicians. These results can promote greater consensus about appropriate care standards.

The first transformation centers on knowing the patient's clinical situation, both past and present. The second and

third transformations involve the patient's future: supplying clinicians with information on the most effective treatment options available to that patient, to the best of our current knowledge. As indicated above, "meaningful use" policies are increasingly incorporating this larger set of objectives.

## Accessible Patient Information

EHRs support clinical quality in the US by helping to ensure that all the information that is known about a patient is available at the time of the clinical encounter. Digitized records, if implemented nationwide, can help make patient data accessible at all times of day at all locations—hospitals, Emergency Departments, primary care facilities, and specialty ambulatory care centers—enabling clinicians to make more informed treatment decisions. EHRs can also alleviate many of the complications that arise from poor provider communication, such as reducing drug-drug interactions.

## Better Clinical Guidance

Through clinical decision supports and other communication strategies, health IT systems such as KP's can update physicians on how patients' care is tracking with current treatment recommendations. As Robert Pearl, MD, Medical Director of The Permanente Medical Group, noted in a highly personal example involving his father, computerized systems can notify clinicians that a potentially life-saving pneumococcal vaccine has not yet been administered.[27] Electronic data also support proactive care delivery outside of the clinical encounter and also allow nonphysicians to be actively involved in eliminating gaps in care.

EHR systems provide the opportunity to improve care delivery by ensuring that best practices are more consistently communicated—and implemented—throughout the system. For example, KP applied these techniques to substantially increase the rate of hypertension control among its members. In KP's Northern California Region, hypertension control rates rose from 44% to 80% over the course of the past decade.[28,29] To achieve these gains, EHRs were used in several ways. Members who had not had a recent check-up were identified and encouraged to make an appointment; electronic prescription systems were

reviewed to identify patients who might benefit from a medication change; and evidence-based clinical practice was supported through electronic support tools.

The following sections provide additional examples where KP has leveraged HealthConnect (or earlier electronic data systems) to improve care delivery.

### Healthy Bones Program

During the 1990s, KP's Southern California Region established the Healthy Bones program, a comprehensive initiative for fragility fracture prevention.[30] Electronic data systems have been used to track medications, use of scanning, and rates of fracture.

The program established large multidisciplinary teams led by orthopedic surgeons. (The fact that surgeons led an effort to reduce fractures is indicative of what an organized system with appropriate financial incentives can achieve.) The teams took proactive steps to prevent fracture, including more frequent bone density scanning, use of fracture risk assessment tools, increased prescribing of bisphosphonates (alendronate), and patient education and encouragement for lifestyle change.

In the largest study of its kind, KP researchers tracked the effectiveness of the Healthy Bones program.[31] The research examined the experience of more than 625,000 patients older than age 50 years who had specific risk factors for osteoporosis and/or hip fracture. These patients were treated under a standardized care protocol. The study found that proactive measures reduced hip fracture rates by an average of 37%. In 2007, a total of 1574 hip fractures were observed, compared with the 2544 that were predicted—meaning that an estimated 970 hip fractures were prevented that year.[32] As millions of baby boomers move into retirement age, these findings become increasingly significant.

KP Southern California now operates a sophisticated data registry that draws clinical information from the EHRs in HealthConnect. The registry data are presented to clinicians through a Web-based tool, enabling them to identify gaps in care across a broad population. Although some variation remains, the organization has become much more consistent in its treatment of osteoporosis and fracture prevention in recent years.[33]

### ALL/PHASE Initiative

In 2003, KP launched its A-L-L initiative to improve cardiovascular and diabetes outcomes by increasing the use of aspirin, lisinopril (an angiotensin-converting enzyme inhibitor), and a lipid-lowering medication. The program was later expanded to include a ß blocker and lifestyle changes, and it was renamed *ALL/PHASE*. As part of the initial A-L-L effort, the organization sought to increase adherence with the three drug regimen and measure the effects of that change.

Numerous clinical trials had demonstrated the cardioprotective benefits of these drugs. In addition, a detailed computer simulation had shown that the bundled use of these medications by high-risk populations could reduce their risk of heart attack and stroke by as much as 71%.[34] Within KP, clinical decision supports encouraged the delivery of A-L-L medications for the eligible populations.

In addition, KP researchers tracked a study population of more than 170,000 members, assessing their adherence to the drug protocol during 2004 and 2005, and then monitoring adverse cardiovascular events in 2006.[35] To increase appropriate drug use, KP physicians and pharmacists developed a simplified regimen involving fixed doses of generic medication that minimized outpatient visits, follow-up laboratory testing, and dosage titration. HealthConnect provided clinical support by flagging eligible patients, those not already receiving both an angiotensin-converting enzyme inhibitor and a lipid-lowering medication (aspirin use could not be consistently measured).

The study confirmed the value of the drug bundle and concluded that 1271 heart attacks and strokes had been averted because of the protocol. Those patients categorized as having high exposure to the drugs saw their risk of hospitalization from heart attack and stroke decline by 26 events per 1000 person years. Those with low exposure saw their risk reduced by 15 events per 1000 person years. The authors predicted that with even higher rates of drug compliance, up to 32,000 heart attacks and strokes could be prevented in a single calendar year.[35]

### Panel Support Tools

Whereas clinical decision-support tools provide alerts to physicians on a case-by-case basis, panel support tools (PSTs) give

primary care physicians an opportunity to review their patients' care gaps at a single glance. Drawing information from the EHR, Web-based PSTs provide physicians with feedback on gaps in patient care relative to evidence-based guidelines. Some KP Regions are also using PSTs to conduct population-level outreach, such as mailings to encourage use of preventive care services.

A recent KP study examined the impact of PSTs on care delivery in the Northwest Region. Focusing on patients with diabetes and cardiovascular disease, and using color-coded visual displays, the PST provided physicians with information on their patients' screening, monitoring, medication use, risk factor control, and immunizations, relative to treatment recommendations.[36]

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Researchers concluded that delivery of recommended care for patients with diabetes and cardiovascular disease did in fact increase following implementation of the PST. Measuring physician performance as the mean percentage of recommended care that each patient received (per month), the researchers found that provision of recommended diabetes care increased from 63.5% to 70.6%, and recommended care for cardiovascular disease improved from 67.9% to 72.6%.[36] This illustrates how EHRs and health IT can be used to support evidence-based practice.

### Continuous Learning and Improvement

In other clinical areas, there may be much less consensus on appropriate care protocols. In these cases, EHRs have the potential to support the generation of new knowledge as a normal part of each clinical encounter.[37] In tracking patient outcomes, electronic data can help form the basis for new understandings about optimal care.

The following examples illustrate how KP has used electronic data from patient registries and observational studies to develop new insight into clinical effectiveness and appropriate practice.

### Tracking Surgical Outcomes

For many years KP has employed registries to assist in tracking groups of patients who have specific conditions, or who have undergone specific procedures. As detailed by the federal Agency for Healthcare Research and Quality, a patient registry is an organized system that uses observational study methods to collect uniform data to evaluate specified outcomes for a predefined population.[38]

One of KP's most sophisticated registries is the Total Joint Replacement Registry. Beginning in 2001, a team of KP orthopedic surgeons, operating room staff, clinical staff, administrators, and infection control officers established what is now the largest total joint replacement database in the country. Across 43 Medical Centers, 350 surgeons voluntarily contribute to the registry with a participation rate of 90%, and more than 140,000 total joint procedures (hip and knee) have been recorded.[39]

The total joint registry provides physicians with feedback on patient outcomes that has informed and, in some cases, altered their views about clinical best practice.[40] For example, one analysis examined registry data to determine which substance worked best in holding new joints in place—basic cement, hybrid cement, or an uncemented compound. The analysis found that joint replacement lifespans were substantially shorter with the uncemented compound, requiring greater numbers of revision surgeries. This feedback on patient outcomes has helped inform subsequent clinical practice.

A recent case study of the Total Joint Replacement Registry observes: "No single doctor working from the experience base of a small medical practice could ever uncover that level of joint survival differentiation. Only with coordinated commitment to tracking comparative effectiveness will we be able to identify and uncover best practices and the value (or lack of value) in new technologies, drugs, devices and treatments."[41]

The registry has been helpful to KP physicians in evaluating manufacturers' marketing claims about their products and in responding to product recalls. In addition, feedback provided by the registry led physicians to change their practice patterns in other ways, such as reducing unicompartmental knee replacements and the use of minimally invasive surgical procedures.[42] Tracking surgical outcomes through the registry has also enabled clinicians to identify the types of patients who are at greatest risk of postoperative infections, second surgeries, hospital readmissions, and other complications.

### Assessing Treatment Alternatives

In a study appearing in the journal *Ophthalmology* in 2010, KP researchers were able to demonstrate that two drugs used to treat age-related macular degeneration (AMD) were equally effective in halting and reversing vision loss.[43] This was an important finding in the ophthalmology community, first because AMD is the leading cause of vision loss and blindness in older Americans, and second because there had been uncertainty regarding the relative effectiveness of the treatment alternatives—ranibizumab (Lucentis) and bevacizumab (Avastin). These medications had a substantial cost differential ($2000 per dose vs $50 per dose).[44]

Using KP EHR data and a retrospective, real-world study design, the KP researchers were able to inform the effectiveness debate in a timely way. The study findings were later supported by a larger National Institutes of Health-funded trial, Comparison of AMD Treatments Trials (CATT), which also concluded that the two drugs were equally effective.

### Developing Treatment Protocols

In the current environment, deriving clear evidence-based treatment recommendations from the literature can be a complex undertaking. Individual research studies are generally not designed for future aggregation and often do not lend themselves to easy synthesis. For example, the authors of a systematic review of 137 studies examining treatments for rotator cuff injury make the following observations:[45]

> The lack of consistency and precision of results across the studies was primarily due to varied comparisons … relatively few studies compared the same interventions. In addition, variation in the pathologic presentation of rotator cuff disease contributed to inconsistency among the studies. Although most patients had full-thickness tears, the size and configuration of the tears, degree of fatty infiltration, and number and type of comorbid conditions varied widely across the included studies. Both outcome measures and timing of measurements varied considerably across studies, which made comparisons difficult.

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[Four major outcomes were assessed in the studies: functional outcomes, quality of life, time to return to work, and cuff integrity.] The most common outcome was function, but 21 different tools were used for this purpose, and multiple tools were often used in the same study.

This example illustrates the complexities involved in transforming research results into actionable advice for clinicians and the fragmentation that often exists within research itself. In this case, the Agency for Healthcare Research and Quality reached a general conclusion that rotator cuff treatments result in "significant improvements" but decided that the evidence was insufficient to support any particular treatment over another or to inform how surgical and nonsurgical treatments might best be sequenced.[46] Consequently, the literature review did not result in greater consensus regarding optimal treatment and further research was recommended.

In documenting widespread regional variation in physician practice in the 1980s, Jack Wennberg wrote that the root cause of variability in health care is a lack of consensus on the correct way to practice medicine.[47] He observed that "all physicians agree on the need for … hospitalization for virtually all patients with hip fractures and myocardial infarction." He said, "Not surprisingly studies consistently demonstrate minimal variations in hospitalization for these diagnoses." Nevertheless, variability was prevalent in many other areas. Wennberg[47] argued that the nation's growing demand for improved quality, efficiency, and equity is "hostage to unresolved theories about correct practice." It is of "extraordinary importance," he said, that we "evaluate reasonably held but inadequately tested theories of treatment … [to ascertain]: What are the outcomes of alternative approaches?"[47] Wennberg's work may have added to the impetus for increased clinical research that occurred over the latter part of the 20th century, as detailed above.

In describing the digital transformation of the 21st century, George Halvorson, Chief Executive Officer of Kaiser Foundation Health Plan and Hospitals, has predicted: "computers will revolutionize health care."[48p213] In *Connected for Health: Using Electronic Health Records to Transform Care Delivery,* he wrote:

*The science of medicine is enhanced when data becomes a regular tool of both medical practice and medical research … We are just now getting access to some very powerful information—learnings that can only be acquired with longitudinal data and data about entire populations of people. [No more] small sample sizes … . In the new world we are headed into, basic [research] studies can be done electronically for much larger populations with a lot more data for a lot less money—and then updated weekly or even hourly. The new database involves years of longitudinal tracking that can turn a research snapshot into a moving picture.*[48p215-6]

The use of health IT has the potential to promote more highly informed and more rapidly informed clinical practice.

## Conclusion

Health IT has been called a necessary but insufficient step in care transformation. EHRs assist in the collection and storage of patient encounter data, but capitalizing on that information requires additional steps to inform treatment decisions.

Buntin et al[49] have argued that the adoption of health IT, if aligned with payment incentives, provides an opportunity to encourage translation of research into broader practice. However, they note that the "human element" is critical. Strong physician leadership and participation are essential in bringing about this change. It is notable that one of the critical components of KP's successful launch of HealthConnect was the effective physician leadership and engagement of clinicians throughout the entire process.[50]

Health IT can support the practice of high-quality evidence-based medicine, as well as continuous learnings and improvement based on ongoing experience. Information and data strategies such as those developed by KP through its patient registries, research, and Web-based tools can aid in efforts to transform care delivery nationwide. ❖

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a Under the Act (Public Law 111-5, Section 3000), the term "health care provider" includes hospitals, skilled nursing facilities, clinics, ambulatory surgical centers, renal dialysis facilities, laboratories, home health entities, pharmacies and pharmacists, group practices, and numerous others.

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