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A Clinical Information System Research Agenda for Kaiser Permanente

Abstract

Clinical information systems (CIS) could drive progress in health care in the 21st century: information captured in a CIS could be used within a general "CIS research landscape" (described by us previously) to develop research projects that examine and potentially improve delivery of health care services. The CIS research landscape also identifies aspects of the care delivery system that must be addressed before quality of care can be improved. In addition, the CIS research landscape portrays the research process and how it relates to operational aspects of health care delivery.

In this article, we describe how we used the CIS research landscape in conjunction with known operational, financial, technical, governmental, and social constraints of Kaiser Permanente (KP) to develop a specific CIS research agenda. We identified four CIS research priorities: clinical decision support systems, population-based care systems, personal health record systems, and establishment of a functional baseline against which future CIS enhancement can be measured. These research priorities should help guide researchers so they can focus their time, effort, and money on important questions that will inform KP and other health care providers about the use of CIS to improve health care.

Introduction

Clinical information systems (CIS) could drive progress in health care in the 21st century. However, to understand their potential uses, benefits, and overall effects on health care delivery, we must examine the organizational and social issues surrounding these information systems. Information captured in a CIS could be used within a general "CIS research landscape" (described by us previously)[1] that enables us to develop research projects to examine and potentially improve delivery of health care services. The CIS research landscape also identifies aspects of the health care delivery system that must be addressed before the quality of care can be improved. In addition, the CIS research landscape portrays the research process and how it relates to operational aspects of health care delivery. In this article, we describe how we used this research landscape in conjunction with known operational, financial, technical, governmental, and social constraints of Kaiser Permanente (KP) to develop a specific CIS research agenda.

Methods

In describing the research framework, we previously presented a grid relating key components of the health care delivery system (ie, patients and families, process of health care, health care practitioners, organizations, patient populations, and clinical knowledge) and key dimensions for improvement of health care (ie, ensuring that the care delivered is safe, effective, patient-centered, timely, efficient, and equitable).[1] Accordingly, we divided our project team into working groups whose subcommittees were each assigned to discuss one component area of the framework.

The subcommittees' work was expected to be representative of KP research throughout the nation as much as possible. To increase the subcommittees' visibility, a Web site was created to facilitate review of the work and communication among a large number of collaborators. The Web site listed references to previous research agenda descriptions; described several CIS-related research projects in progress or in the proposal phase; and outlined the research agenda framework. In addition, we developed a Web-based messaging system that allowed all interested parties to communicate about the documents posted.

Each leader of a research framework area identified four to ten additional KP researchers to help identify and clarify specific research questions within that framework area. The research questions identified were neither exhaustive nor prioritized. Reports from individual research areas were posted to the Web site for review and comment.

Each subcommittee worked to further refine a description of the research areas. Members of the subcommittees quickly realized that each area overlapped with, depended on, or related to each of the other areas in one or more ways. The following sections briefly describe how each subcommittee conceptualized its task.[1]

Subcommittee Topic 1: Patients and Families

Research questions about effects of CIS on patients and their families have two distinct dimensions: 1) patient-related information encoded by the CIS and 2)

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care-related processes or practices (created by health care organizations) that characterize how patient-related information is or could be used. The CIS contains four categories of encoded patient-related information: 1) representation of the patient's medical history; 2) representations of the patient's current health status; 3) representations of the patient's or clinician's future plans; and 4) representations of knowledge related to the patient's information (eg, diagnosis- or intervention-related information). These two dimensions—CIS-encoded patient information and the processes that characterize its use— give us a convenient way to conceptualize research questions of interest to subcommittee members researching effects of CIS on patients and their families.

Subcommittee Topic 2: Health Care Practitioners

Because they deliver health care to patients, clinicians are the primary generators of health information data. In addition, clinicians need access to the data for several purposes: 1) to interpret these data for patient and population-based management decisions; 2) to analyze the data for outcome studies; 3) to develop evidence-based guidelines and decision support tools; and 4) to monitor performance of individual clinicians as well as quality of the care delivered by the health care organization.

The slow, cumbersome methods available for data input have been an important obstacle to introducing the electronic health record into medical practice. Further, many clinicians balk at entering data into computerized medical records; these clinicians assert that they are "professionals, not data entry clerks." These problems highlight

opportunities that challenge researchers to create better methods for enhancing the patient-clinician-computer interface. We must explore how to facilitate use of computers during patient visits. Research findings that improve the patient-clinician-computer interface would promote adoption of this technology on a wider scale.

Clinicians not only need easy-to-use computer interfaces to rapidly input data; clinicians also need rapid access to data for managing the care of individual patients and patient populations. Access to data involves both local and remote access while care is being delivered. Access to data may also involve short- and long-term analyses of patient and population outcomes that can inform processes of care and enrich clinical information and knowledge.

Subcommittee Topic 3: Health Care Delivery Organizations

Adoption of a CIS presents challenges as well as opportunities for health care delivery organizations. Specifically, a CIS can:

- Allow information to be delivered using new structures or methods, such as a virtual medical center accessible via the Internet;
- Help manage information existing within the health care delivery structure: disseminate new information and practices to clinicians, evaluate changes, and integrate care; and
- Enhance ability to conduct research and to generate new knowledge on various patient populations.

The technologic innovation necessary to support these changes represents major capital invest-

ment that could transform the organizational structure of health care systems and reshape relationships between the health care organization and its clinicians, the patients they serve, and other organizations involved in the health care system (eg, health care insurers, employers, and suppliers). The organizations could improve in quality, productivity, and service; they could better integrate different clinical areas; and they could improve the processes used to coordinate operations, both within and among organizations. Potential harm introduced by this technologic innovation includes loss of confidentiality and creation of a more fragmented delivery system because of poor or incomplete implementation and resultant loss of data integration.

Subcommittee Topic 4: Clinical Data, Information, and Knowledge

"Data," "information," and "knowledge" are interrelated concepts but are not defined identically. These three concepts can be represented on a continuum with "data" at one end, "information" in the middle, and "knowledge" at the other end. Each step along this continuum represents added meaning or content; information is the synthesis of various data elements, and knowledge is the synthesis, or generalization, of various types of information. In this section of the CIS research agenda, we examined this entire continuum, how it relates to systems

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in health care, and specific implications for studying CIS content.

At one end of this research spectrum, this examination overlaps with clinicians because they are responsible for reviewing the data and knowledge and entering it into the CIS. At another edge of the spectrum, the content of a CIS interacts with populations because, by combining data from individual patients, a "population" is identified. At yet another edge of the spectrum, the content of a CIS interacts with patients whenever data must be collected from them or presented to them as an overview. If the CIS successfully incorporates various forms of operational information (eg, surgery or on-call schedules) and clinical knowledge about the care processes, then this area of research will overlap the organizational and procedural sections of the agenda.

Subcommittee Topic 5: Patient Populations

Patient populations are formed or identified on the basis of clinical, demographic, or financial information common to a particular set of individual patients. After a specific group of patients has been identified (a process which can be greatly facilitated through use of sophisticated search techniques on a CIS database), clinicians become concerned with management of these patients' care. Health care organizations are concerned that members are treated fairly with the highest service standards and by optimally using available resources. Clini-

cians and administrators are interested in developing optimal processes to address health care needs. Each patient in the specific population may wish to obtain practical and emotional support from other patients with a similar medical condition.

Subcommittee Topic 6: Processes of Health Care Delivery

"Work processes" are the means by which health care is delivered. These processes may be consciously developed through intense collaboration among members of the health care team or may simply be a continuation of past practice. Implementation of a CIS often has a profound impact on such routine health care practices done repeatedly for many years. In attempts made over the past several years to improve health care quality while reducing costs, many processes have been examined in minute detail. In many instances, the impact of a process on one particular participant in the health care delivery system is positive but is negative for another participant.[2] Debate has surrounded the question of whether a CIS should be designed around existing work processes in an organization or whether the CIS should be a catalyst for change.[3] A CIS may be used to improve control of work processes, but addition of the CIS often changes the process so that the old process becomes irrelevant, unproductive, counterproductive, or nonexistent. Changing the way health care practitioners and teams accomplish their work is one of the most challenging activities undertaken in the health care delivery system. All participants in the health care delivery process interact within this research area.

CIS Research Application
Identification of Specific Research Questions and Potential Projects

Research agendas are never totally free of external constraints, although they are often discussed as if such constraints either never existed or have no appreciable effect on the relevant science. In reality, these constraints are important. Researchers and funders must explicitly incorporate external and internal operational constraints into the CIS research agenda. These constraints include organizational knowledge, skills, and capabilities, technologic opportunities and challenges, financial constraints, and government regulations. Figure 1[4] illustrates this process.

These constraints help to focus the research agenda. Research outcomes should alter the operational environment to improve the patient's care experience, the work lives of clinicians, the ability of clinicians to manage large patient populations, the processes used to deliver the health care, or the organization's efficiency. Research outcomes should create new data, information, and knowledge that furthers our understanding of both the health care delivery system and our health plan members.

After each subcommittee developed a shared understanding of its particular research area, the subcommittee listed ex-amples of research questions[a] that could be explored within each area that *Crossing the Quality Chasm*[5] identified for potential improvement. Using these lists of potential research questions, each subcommittee began to identify key research projects that could be undertaken to answer these questions. The next section describes the process used by each subcommittee to identify the highest-priority CIS-related research projects for KP.

CIS Research Priorities for Kaiser Permanente

After we developed the full range of potential research questions and projects, we applied the external and internal constraints discussed above and identified several CIS research priorities: clinician decision support systems, population-based care systems, personal health record systems, and baseline criteria for measuring future CIS enhancement.

Clinical Decision Support Systems

We must develop information management tools to help us acquire, manipulate, apply, distribute, and display appropriate clinical knowledge to clinicians and patients at the appropriate time and place to help them make correct, timely, and evidence-based clinical decisions. Accordingly, two key research questions must be answered:

- What are the most effective methods for representing the complex clinical knowledge required to facilitate data entry, review, analysis, and synthesis for clinicians at the point of care?
- How does presence of clinical decision support (eg, re-

CIS Research & Development within Kaiser Permanente

Health Care Entities
- Patients
- Providers
- Processes
- Populations
- Organizations
- Information

Key CIS R&D Efforts
- Clinical Data Repository
- Clinical Knowledge Repository
- Patient access to clinical information
- Establish a baseline

Outcomes Expectations
- Safe
- Effective
- Patient-centered
- Timely
- Efficient
- Equitable

Operational Health Care Environment

Organizational Knowledge/Skills/Capabilities
Technological Opportunities/Challenges
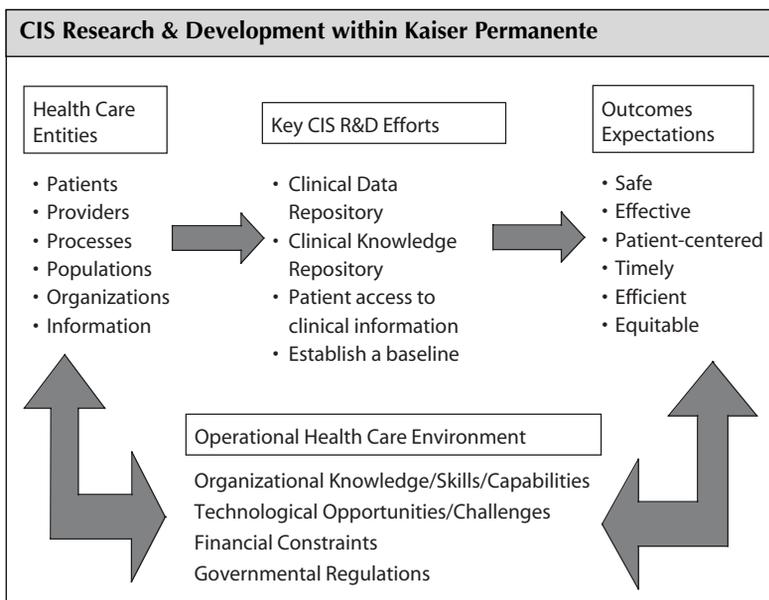Financial Constraints
Governmental Regulations

Figure 1. How key participants and areas for improvement are influenced by the operational environment of an organization when a general research agenda is applied to a specific research and development plan.

(Adapted and reproduced by permission of the publisher and author from: Stead WW, Lorenzi NM. Health informatics: linking investment to value. J Am Med Inform Assoc 1999 Sep-Oct;6(5):341-8, Figure 1.[4])

minders about drug-drug interactions or suggestions for using less-expensive, alternative medication) at the point of care affect the quality of care delivered as well as the efficiency of clinicians?

Population-Based Care Systems

We must develop systems that enable us to create large, integrated databases of patient-specific information that allow clinicians to begin real-time management of populations of similar patients. Mining data in these databases may provide insight into new associations between disease states and how to effectively manage them. Two key research questions must be answered:

- Can we develop systems that scan all clinical and administrative databases for events and conditions that signal imminent serious decline in health status (eg, stroke, heart attack, fall, hip fracture, and vertebral fracture) and that enable us to intervene in time to prevent these conditions?
- Can we develop large, disease-specific patient registries that enable us to identify best practices sooner and with less expense than currently?

Personal Health Record Systems

We must develop new information management technology that enables patients to begin taking more responsibility for their health and for their health care. These systems must provide patients easy access both to their

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shared personal health record data and to reliable patient-specific information resources that help patients to decipher complex medical data. Patients can then participate in the clinical decision-making process while ensuring the privacy and confidentiality of their medical information. Two key research questions must be answered:

- Will patients use a system that allows them to enter and review their personal clinical information from a shared copy of their electronic medical record?
- How will availability of patient-specific clinical information, coupled with the ability to send secure messages to the health care practitioner, affect the clinician-patient relationship?

Baseline Criteria for Measuring Future CIS Enhancement

We must develop methods for establishing baseline criteria against which future CIS enhancement can be measured. These baseline measurements must take into account the quality of care delivered, as well as the patient's overall health status,

clinical productivity, and cost estimates. In addition, we must develop techniques for assigning quantitative value to these otherwise qualitative estimates. Two key research questions must be answered:

- How can we create reliable, baseline estimates of the important aspects of current functioning of our health care delivery system so that we can determine the impact of the CIS after it is implemented?
- How can we establish metrics for quality of care, quality of service, and overall patient health that can be used to calculate cost-benefit or return-on-investment ratios achieved after a CIS is implemented?

Summary

Clinical information systems (CIS) may represent one of the most important tools in delivery and management of health care. We identified four CIS research priorities for Kaiser Permanente (KP): clinical decision support systems, population-based care systems, personal health record systems, and a baseline against which future CIS enhancement can be measured. The CIS research agenda described in this article is only

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one possible research agenda that could be developed, but this agenda provides KP with an accurate and valuable map of the CIS research landscape. This landscape should help guide researchers so that they can focus their time, effort, and money on important questions to inform KP and others about how to use CIS to improve delivery of health care. ❖

[a] A complete list of the exemplar research questions from each of the six sub-committees is available at http://kpchr.org/ACIRN/agenda/appendix.pdf.

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