Adopting Knowledge Technology to "Manage" Care: Issues and Status of Physician Use

OBJECTIVE: To determine the extent to which primary care physicians have been willing to incorporate computerized protocols and clinical information systems into their practices.

DESIGN: A survey was fielded to both primary care and nonhospital-based specialty group practices of five physicians or more.

MAIN OUTCOME MEASURES: The types of these technologies in use and the degree to which the physicians themselves were active users.

RESULTS: Findings (n=197 or a 38% response rate) are presented grouped by three stages of software application adoption: (1) transaction; (2) decision support; and (3) expert systems or simulation of human thought. Transaction systems, particularly applications that support practice administration such as registration, billing, and scheduling, have the highest percentage of adoption (82% to 97%). Expert systems are uncommon (3% to 6%), with slightly higher penetration of telephone triage (such as "ask-a-nurse") and prevention reminders applications (11% and 19%, respectively). Within group practices, physician "hands-on" use of systems is low for viewing (28%), and even lower for entering patient information (6% to 8%).

CONCLUSIONS: Emerging knowledge technologies such as medical decision support or expert systems are not widely accepted and may even threat-

en traditional physician domains of expertise. Explicit consideration of potential physician opposition should be included in planning pharmaceutical management strategies that depend on "hands-on" physician computer use to be successful.

KEYWORDS: Knowledge, Adoption, Protocols, Expert systems, Physicians, Benefit management, Managed care

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The development of practice guidelines, protocols, and clinical information systems has widely outpaced the use of these tools by physicians. The unwillingness of some physicians to adopt these "soft" technologies limits their widespread utility (not only for physicians, but also for pharmacists, nurses, and allied health professionals) in making needed improvements in the quality of health care and increasing efficiency.

Is Physician Use Required?

Information technology can provide a path to improved real-time, information-driven clinical care.¹⁻³ But when managed care organizations (MCOs) consider using clinical information systems to improve care and reduce costs by providing decision support to physicians on "best practices" in pharmacotherapy and disease management, they must consider the very limited degree to which the medical profession has adopted these systems.

The single most important force determining the cost and quality of health care today remains the physician. Eisenberg estimates that physicians directly control the spending of 90% of health care dollars.⁴ Each physician's decisions account for an estimated annual average of \$500,000 to \$800,000 of health care expenditures, not including their own fees.⁵ Changing physician behavior is thus crucial to reducing health care costs or modifying delivery systems.⁶

Many physicians would agree that an information system that organizes health care reference information and makes it easily accessible to them would be acceptable or even desirable. More reference literature is published in health care today than the typical practicing physician can follow, review, and adopt.^{7,8} So much information is being generated, Gross and colleagues believe, that physicians actually attend to less of it, arbitrarily reducing information to a manageable level.⁷

If the physician never looks at disease management protocols or enters prescriptions and orders into a clinical information system, then that system cannot provide interactive feedback to the person who can take action. Systems that provide information to physician's office personnel will not change patient care, because only the physician is qualified to alter the treatment plan. At best, feedback on ways to improve quality or lower costs will only be retrospective.

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In pharmacy, most work has become semiautomated.⁹ In contrast, the core work of physicians—diagnosis and treatment, as well as creating the patient medical record—is still essentially manual.¹⁰⁻¹² Most physicians do not actively use information technology for their core work. The critical issues that affect physician use of information systems are not technical, but social.^{10,13-14} Information technology allows third parties to monitor physician performance and place restrictions on diagnosis and treatment decisions. Technology can also reduce demand for physician services by creating units of knowledge that can be delegated to nurses, clinical pharmacists, or other nonphysicians.¹⁵⁻¹⁷

Physicians have, to some degree, the power to veto information technology systems in use for patient care.¹⁸⁻¹⁹ The power of physicians to restrain the use of computers in the critical processes of patient care is unequalled in any other health care profession. Information systems accepted by nonphysicians—including those that integrate medical and pharmacy data—might not be implemented simply because physicians reject the system.^{12, 19-21} Ultimately, physicians must at least condone the use of clinical information systems for pharmacy benefit or disease management if such systems are to be successfully implemented.

An early and prominent example of how physician opposition can halt a clinical information system occurred in 1977 at the University of Vermont. Dr. Laurence Weed computerized his manual Problem Oriented Medical Record to create the Problem Oriented Medical Record Information System (PROMIS). PROMIS mandated that physicians follow "expert rules" of data collection before making diagnosis and treatment decisions. The Department of Medicine at the University of Vermont endorsed co-developing PROMIS over a four-year period. During the pilot, some physicians and most nurses responded favorably, but many physician users entered "free text" rather than selecting formatted responses, enabling them to escape the expert rules. Although pharmacists—long-time proponents of computerized systems—were strong advocates of the system, the physician staff voted to discontinue use of PROMIS, and the entire system was scuttled despite the enormous labor and capital investment.^{21,22}

■ System Classification Framework

Historically, computer technology has been adopted in stages that also define levels of organizational impact.^{23,24} Early in the history of computers, Leavitt and Whisler defined three stages of information systems that are still valid today: (1) creation of large-scale data handling or transaction systems; (2) development of decision support systems applying statistical techniques to databases; and (3) simulation of human thinking with computers.²³ By the early 1990s, most industries in the U.S. had two decades of experience in data handling and had advanced into using technology to improve efficiency and decision making. Many businesses were experimenting with the use of technology to simulate human thinking. The health care sector has lagged behind.

Although the first stage of information system use—large-scale data handling or transaction systems—is common in the health care industry, the second and third stages are not. A 1997 study of 6,201 hospitals revealed that 5,423 had financial systems.²⁵

Another study indicated 75% of clinics had financial systems.²⁶ However, information systems to support physician decision making or simulate human thinking have not been widely adopted in health care, although such applications have been developed and are available.²⁷⁻²⁹ In 1992, an industry expert estimated that no more than ten clinical decision support systems were in active use.³⁰

Typically, potential users resist the advent of information technology because they see the use of these systems as a threat to themselves and their autonomy. These threats parallel the categories in the framework described above. Staff and clerical users of large-scale data handling systems are threatened by monitoring and control at the task level. In the next two stages, greater surveillance of resource utilization decisions threatens professional and managerial users. At the top level, executives who use information systems less intensively face the threat posed by having to rationalize previously unstructured decisions.

■ Physician Opposition To Information Technology

Three studies have reported direct measures of physician opposition to medical decision support. Teach and Shortliffe surveyed physicians attending a seminar on artificial intelligence in medicine, as well as a group of local physicians. Physicians favored automation for core physician work such as diagnosis and treatment only when applications were presented as clinical aids, such as Medline, rather than replacements, such as computer-aided diagnosis.³¹ Another study of academic physicians, private practitioners, and house staff revealed that almost 70% of the physicians thought the computer was desirable as a source of summaries of published research, but only 28% wanted a computer to provide probability estimates for a diagnosis, even using patient clinical data as the basis for the probabilities.³² A third survey that measured attitudes of physicians, residents, and medical students at a large academic hospital found that physicians viewed large-scale data management systems, such as charge capture and pharmacy transaction handling systems, as more desirable than medical decision support systems. They opposed systems that would permit allied health professionals to take on even a limited number of traditional physician activities. While they believed computers would lower costs and improve quality, they also believed computers would result in a loss of physician autonomy.¹⁸

Physician opposition to computerizing medical decision making has been expressed more subtly than the resistance of blue collar and office workers to information technology.³³⁻³⁵ Physicians' refusal to adopt a computer system is commonly ascribed to technical barriers, such as a lack of features or training, rather than to their opposition to using any and all computer information systems. This perception has caused much research in medical informatics to focus on technical barriers to physician acceptance of clinical information systems.^{30, 36-37}

Significant technical barriers to physician acceptance do, in fact, exist. Physician data entry in an automated patient record disrupts current procedures and takes more time than entry in a manual patient record.³⁸ Seamless incorporation of physician

use is impossible. Even automated flowsheets impose data entry requirements not required by the manual record. Unfortunately, clerical input of physician data is expensive.³⁹ In 1998, for a major academic medical center in the central states, the annual cost of physician transcription for even a select subset of dictated notes was estimated at \$325,000.

Information system creators often assume that features that alter access, ownership, and control of information will sell themselves because the features obviously benefit the organization. However, they overlook how users are rewarded or punished for sharing or withholding information—information politics that is almost never formally documented.⁴⁰⁻⁴¹ If the physician receives no reward for using a decision support or expert system, or is not penalized for failing to use the system, then that physician is unlikely to share his or her decision-making authority.

Challenges to the physician monopoly of health consulting and physician values are powerful forces that help to drive physician opposition to clinical information systems and standards, as several social science theories would predict.¹³⁻¹⁴ The automation of medical information challenges physician domination of health care, and allows outsiders to question the physician's knowledge.²⁶ If, as many experts claim, only 10% to 20% of medicine is known with certainty, knowledgeable experts may well disagree.⁴²⁻⁴³ Given this uncertainty, physicians have been socialized to guide their practice from personal knowledge and experience.⁴⁴⁻⁴⁵ A clinical expert system that recommends treatment regimens contrary to the individual physician's personal experience would threaten the validity of the physician's core value system.

Managed Care's Impact on Physician Opposition

As discussed earlier, physicians have controlled most health care spending in the fee-for-service environment. A physician with an income of \$200,000 has generated an estimated annual revenue stream (often for a hospital) as high as \$1 million in this environment.⁴⁶ Virtually no hospital administration has mandated that physicians use computers, fearing that physicians opposed to clinical information systems would take their patients elsewhere and disrupt that revenue stream.

This tacit threat began to lose its power as payors demanded greater control of health care spending through managed care, certification, or compliance programs. Physicians are being replaced as the final arbiters of health care spending because under pressure from patients, hospitals, and others, they may become less likely to order testing or therapy that is not covered by third-party payment. In some decisions, such as in the application of high cost therapies such as magnetic resonance imaging, physicians must obtain pre-authorization. As more patients shift from unrestricted fee-for-service reimbursement to managed care, physicians lose autonomy.

Neither health plans nor government has full authority to direct patient treatment. Physicians do. Managed care plans achieve control by setting care standards through protocols and by implementing drug formularies.^{2, 47-48} Protocols reduce physician autonomy and routinize some aspects of care, which

enables nonphysicians to deliver more care.^{21, 49-50} By insisting on and enforcing standards, large payors have provided financial incentives for physicians to conform to standards, in effect "rewarding" physicians for changing their behavior.⁵¹ Information systems technology adds a powerful tool for delivering and monitoring standards.^{43, 52-53} When physicians use a clinical information system to determine and record patient care interactively, the system provides the ideal medium for communicating protocols and rules.^{48, 54-55} The U.S. Agency for Health Care Policy and Research, recognizing this fact, plans to translate its guidelines into computer formats.^{43, 56} In addition, the clinical information system provides the capability to record adherence to the protocol.

Penetration of Information Systems in Ambulatory Practice Settings

To determine the extent to which physicians have adopted clinical information systems, 522 nonhospital-based specialty or multispecialty groups with five or more physicians were randomly selected from the American Medical Association (AMA) group practice census to receive a survey. The subspecialties family/general, internal medicine, pediatrics, obstetrics/gynecology, psychiatry, cardiology, and gastroenterology were included because they were most likely to contract with MCOs. The survey was to the group practice administrator. The survey methodology included a presurvey letter, the survey, and a postcard reminder. All nonresponders were sent a second mailing of the survey and, finally, were contacted by telephone and faxed a copy of the survey.

Survey findings from the 197 respondents are presented. Adoption of 34 medical software applications was measured. In keeping with Leavitt and Whisler's framework, the findings group applications by three stages: (1) transaction; (2) decision support; and (3) simulation of human thought or expert systems.²³ However, systems are often packaged by vendors with features that cross the stages of the framework, particularly in the case of stand-alone department systems such as pharmacy and laboratory. For example, virtually all pharmacy systems today include drug/drug and drug/allergy interactions, and most laboratory systems can automatically order an additional test dependent upon the results of an initial screening; these functions could be considered simulation of human thought.

As shown in Table 1 (see page 38), most nonhospital-based specialty group practices have adopted stage one transaction systems. These systems are the meat and potatoes of information management, holding fields of data at the greatest level of detail at which the data can be defined. Transaction systems that record patient name, address, billing, and insurance information are widely used. Systems that record data specific to the clinical aspects of patient encounters (other than ancillary test results) but that are not related to billing are more sporadically used.

As information systems advance and develop, transaction systems feed the data they capture into higher-level system applications with decision support or expert capabilities, which apply statistical techniques to databases for probability analyses. A lack of patient-specific clinical data makes migration into the

decision support stage impractical. For example, a large-scale transaction database that includes the patient's complete medical record increases the likelihood that a complete medication history is available. A comprehensive medication history allows stage two or three support systems to check for duplicate prescriptions, overdosing, overtreatment, and adverse effects from drug interactions.⁵⁷ Without large-scale transaction systems as a base, stage two or three support systems would require the user to enter all the known medications for the patient before the clinician could receive feedback on interactions or therapeutic duplications.

Transaction data for pharmacy appeared in computerized databases early on, but traditionally these databases have been separate from medical databases in both inpatient and ambulatory settings. When a physician gives a patient a prescription during an office visit, the physician may make a note in the paper medical record or the office computer system. However, the prescriptions are typically filled at community pharmacies, where detailed pharmacy transaction data is recorded. These transaction databases belong to the drug store chain and are rarely integrated with medical transaction databases.

Some pharmacy benefit management companies (PBMs) have made strides in this integrative activity, but as a whole, the PBM industry has yet to become the "health information managers" once predicted. Inpatient pharmacy charges typically originate in departmental pharmacy systems. Summary billing data will be pulled into the billing process, which will include data on the diagnosis-related grouping and final primary diagnosis. However, for both inpatients and outpatients, the

detailed pharmacy transaction database may be limited to information only on drugs prescribed, days supply, dosage, the physician, the pharmacy, and the insurance payment. The diagnosis is often absent because the data were not required for reimbursement.⁵⁸

The survey indicated that 18% of physician group practices use pharmacy management systems, but only 4% had systems for concurrent review (see Table 2). Because few physician practices capture comprehensive medication histories, the pharmacist is more likely to have an information system that provides useful feedback on drug interactions, duplications, and other medication-related information. Unfortunately, the authority to change the prescription rests with the physician, who does not receive this feedback. Changing the prescription requires additional communication between the pharmacist and the physician.

The last stage of the system adoption framework involves using systems that simulate human thinking—those with "expert" capabilities. As transaction databases feed decision support systems, those support systems set the stage for providing "expert" feedback. This next step involves providing information in a more specific patient context and making complex information more useful.

Broad consensus holds that the human mind can balance only a limited number of variables—possibly fewer than seven—before the amount of information makes it difficult to arrive at a consistent diagnosis and treatment decision.^{42,59} Computers do not have this limitation, and thus can be very helpful in evaluating an unlimited number of variables. For example, LDS Hospital

TABLE 1
Transaction Systems in Use by Nonhospital-Based Specialty Group Practices of Five or More Physicians (n=197)

Application	Survey Description	%
Registration	Patient or member registration and basic demographic data	97%
Billing	Automated patient or member billing	96%
Electronic commerce	Electronic commerce (e.g., claims for Blue Cross/Blue Shield or other third parties)	86%
Scheduling	Patient or procedure scheduling and tracking	82%
Office visit coding	Procedure, diagnosis, or office visit coding (for uniform billing, reporting, etc.)	75%
Laboratory	Data links to external systems or departments—laboratory	55%
Link with hospital	Office system link with hospital information system	53%
E-mail	E-mail (other physicians, patients, outside consultants, etc.)	45%
Link to literature	Computerized professional literature (books, journals, citation databases, etc.)	35%
Authorization tracking	Managed care referral authorization tracking	30%
Radiology	Data links to external systems or departments—radiology	26%
Encounter (clerk transcribed)	Clerk transcribed physician office or telephone encounter (back-entered)	23%
Order entry	Order entry (e.g., lab, radiology, EKG, etc.), consults, and treatments	20%
Transcribed dictation	Transcribed physician dictation (viewable from outside the word processing system)	16%
Progress notes	Physician progress notes	15%
Encounter (other providers)	Data from other provider encounters (emergency room, home, hospital, etc.)	14%
Problem list	Master patient problem list	12%
History & exam	Physician history, physical exam, and other findings	11%
Encounter (nonphysician)	Nonphysician licensed caregiver entered office or telephone encounter (real time)	8%
Patient teaching	Patient teaching support (instruction and charting of instruction)	6%
Patient flowsheet	Patient flowsheet (diabetic, blood pressure, or other special purpose)	6%
Patient history questionnaire	Patient history questionnaire responses	4%

TABLE 2

Decision Support Systems in Use by Nonhospital-Based Specialty Group Practices of Five or More Physicians (n=197)

Application	Survey Description	%
Pharmacy management	Pharmacy management (medication lists, drug interactions, print patient prescriptions)	18%
Satisfaction tracking	Patient or member customer satisfaction tracking	10%
Management audits & queries	Medical management audits or research queries	8%
Concurrent review	Concurrent review (e.g., quality indicators or case management)	4%

TABLE 3

"Expert" Systems in Use by Nonhospital-Based Specialty Group Practices of Five or More Physicians (n=197)

Application	Survey Description	%
Prevention reminders	Health prevention and screening reminders (e.g., mammography)	19%
Telephone triage	Patient telephone triage system (e.g., "ask-a-nurse")	11%
Protocols (administrative)	Administrative practice protocol/guidelines (for authorizing specialist or other services)	5%
Protocols (interactive expert)	Interactive clinical protocol/guideline or "expert" system (automatically checks patient data)	3%
Voice recognition dictation	Voice recognition dictation (transcribed automatically)	3%
Protocols (stand-alone expert)	Stand-alone protocol/guideline or "expert" system (user enters patient data)	3%
Protocols (drug)	Pharmacy drug protocols	3%

in Utah reported that its Adult Respiratory Distress Syndrome ventilator management protocol, which manages 246 variables, increased patient survival rates from 9.5% to 44% and is being adopted in other hospitals.^{42, 60-61}

Table 3 demonstrates that the penetration of "expert" systems is minimal. Health prevention reminders, in use at 19% of the practices, had the highest level of penetration. Telephone triage systems ranked second (11%), but the primary users of telephone triage systems are nurses.^{62, 63} Computerized protocols have been adopted in no more than 3% to 5% of the group practices.

■ Direct "Hands-On" Use of Information Systems By Physicians

Survey respondents in each group practice were also asked to estimate actual "hands-on" use of computer systems by physicians. The average usage across survey respondents is presented in Table 4 (see page 40). In these group practices, the majority of physicians do not use a clinical information system to view results or other patient data. Use of systems by physicians to enter data or for expert advice is considerably lower (6% to 8%).

■ Discussion

The penetration of sophisticated information systems capable of interactive delivery of drug protocols is quite low (3%). In addition, physician "hands-on" use of information systems for even viewing data is low. Interaction with a drug protocol in real time—the ideal circumstance to optimize drug orders and prescriptions—requires that physicians enter orders rather than simply view patient results, medical literature, or drug formularies. That is the only way the physician can get immediate feedback on ways to optimize drug choices for the best outcomes at the lowest cost. Across group practices, physician use of information systems for entry or interaction with protocols is minimal

(6% to 8%). With such low levels of "hands-on" physician use, designing computer-based interactive interventions to improve utilization of the pharmacy drug benefit is analogous to sending electronic messages to recipients who never check their e-mail.

■ Limitations

The study has several limitations. Using an informant survey method can introduce error. The survey was addressed to the practice administrator as spokesperson for the practice. This person may not have understood which computer applications were used by the practice and/or may have not known the extent of physician use of computer applications.

In addition, the response rate for this survey was 38%, which may have introduced a nonresponse bias. However, in large-scale surveys, even a 50% response rate has been difficult to achieve, and the response rates seen in mailed surveys to group practices have been even lower. The AMA has had only a 35% response rate to its own annual group practice survey. Nonresponse bias presents a threat to validity and may limit external generalizability.

■ Implications For Health Care Leadership

Today, computerized drug protocols exist that are updated in real time based on laboratory results on drug resistance.⁶⁶⁻⁶⁷ However, if the system requires interactive use by physicians to provide the benefit, then caution is in order. From the physicians' point of view, computerized data sets could become the basis for regulation and monitoring of their practices. Depending on the environment, PBMs might want to consider a staged strategy that starts with paper-based drug protocols, preprinted prescription sheets, and online drug information before building to interactive computerized drug protocols. Financial incentives for use of drug protocols is another potentially effective

TABLE 4 Average Percent Physician Use of Computers in Nonhospital-Based Specialty Group Practices of Five or More Physicians (n=197)

Type of Use	Percent Physicians Within Group
Viewing	28%
Management or research	14%
Entry	8%
Expert advice	6%

strategy. For example, one study found financial incentives (denial of payment) reduced the use of injectable antibiotics by 60%.⁶⁸

Nonhospital-based physicians have not widely accepted information systems technology. As long as physicians continue to resist such systems, the benefit this technology could bring to health care will be largely unrealized, not only in the day-to-day delivery of cost-effective care, but also in the availability of health care information for analysis.

Little doubt exists that such large data sets present untapped information sources. For pharmacy, with 95% of drugstores computerized by the early 1990s, very rich transaction data bases exist, with enormous potential for data mining.⁶⁹ The only information superior to this type of evidence-based knowledge comes through randomized controlled trials.^{3, 70} The cost and time to retrieve and summarize this detailed clinical patient data from paper medical records is prohibitive; the cost of gleaning research data from manual primary sources has been estimated at approximately \$65 per record in 1982 dollars.⁷¹ Acquisition of this information is cost effective only if the information is readily available as a by-product of delivering care.

The implementation of information systems has failed at a rate of 50% or more.⁷²⁻⁷⁴ Nevertheless, health care organizations continue to invest millions of dollars in their development and support. Health care organizations surveyed by *Modern Healthcare* projected spending an average of \$8 million per year on information systems; over half the respondents projected spending more than \$11 million per year.⁷⁵ Capturing, storing, and processing information accounts for an estimated one-third of all health care expenditures in the United States.⁷⁶ Spending is high because the potential benefit is equally high. Data collection systems to automate the clinical record alone could save an estimated \$40 billion to \$80 billion annually.⁷⁴

Clinical information systems must be adopted by the entire health care organization or by none of it. Maintaining dual systems to accommodate those who refuse to use the computerized record can increase costs by 130% to 240%.⁷⁷ The estimated cost of supporting an electronic medical record is about \$5,000 per physician.⁷⁸ Although limited pilot projects can be supported on an interim basis, the organization ultimately must make a "go" or "no go" decision.

Fee-for-service plans are in decline; only 15% of all active employees enrolled in indemnity plans for 1997.⁷⁹ But where fee-

for-service plans remain dominant, physicians retain significant power in deciding whether to implement clinical information systems. PBMs should initially select information management projects that do not require direct physician use. For example, beginning with computer applications that monitor filled prescriptions and provide retrospective feedback on costs to physicians might be preferable to implementing interactive drug protocols that would require physician use. Further implementations must be carefully planned to allow physicians time to build a level of comfort with and trust of the information system. Many of the benefits of information systems will be postponed until physicians become active users of such technology. ■

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