THE PROMISE OF COMPUTERIZED PATIENT RECORD SYSTEMS FOR OFFICE PRACTICE

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Imagine you are a general internist who joined a large multispecialty faculty practice after completing your residency. Although a few newer members of the practice have advocated implementing a computerized patient record system, this has not yet happened due to concerns raised by other physicians in the group.

This morning you are scheduled to see 12 patients. The first, Ms. Saracino, is a 68-year-old woman with a 10-year history of type 2 diabetes well controlled on a combination regimen. She also was recently started on medication for hypertension and hypercholesterolemia. Ms. Saracino is here for a follow-up visit. She had her blood drawn yesterday as you requested, and she needs refills of all her medications.

While heading for the exam room you learn that Ms. Saracino's chart is with the nursing refill team and her laboratory results have not yet arrived. You review her home blood sugar levels and blood pressure reading from today and establish that she is feeling well. You then ask her to wait while you have the results of yesterday's tests faxed from the laboratory, explaining that you need to review the results to determine whether you should adjust her current medications.

Your second patient, Mr. Klein, is a 53-year-old man who is here to discuss whether or not he should have surgery for his intractable GERD. He reports that he saw the gastroenterologist and general surgeon as advised, but he is confused about what they told him. He has information about GERD that he found on the Internet, which he wants to discuss with you. You search his chart for reports from the consultants, but they are missing. You excuse yourself while the nurse calls the specialists to have their reports faxed and you return to Ms. Saracino.

Ms. Saracino's laboratory results confirm that her diabetes is well controlled, so she does not need any change in her medications. The chart is still not available, so you call her pharmacy, confirm her most current medications, and authorize refills. Ms. Saracino does not remember that at her last visit you changed the dosage of one of her medicines and after the visit she took the prescription to a different pharmacy than she normally uses. Being unaware of this, you have inadvertently refilled the medication at the wrong dosage.

When Ms. Saracino is gone, the nurse brings back Mr. Henderson and hands you Ms. Saracino's chart, which has a flag on it indicating she is due for a flu shot in 1 month. You forgot to remind her. The nurse also informs you that the billing was rejected on one of your patients because the wrong ICD code was used and the note recorded for the office visit did not support the CPT level billed.

Mr. Henderson, a 92-year-old man with Alzheimer's disease, is here with his wife to follow up on a complaint of persistent dizziness. He is a patient of one of your partners, who is on vacation. The couple gave an extensive history last visit, but you cannot read your partner's handwriting and you begin the laborious task of starting from scratch. You finally establish that Mr. Henderson's benign positional vertigo has persisted despite meclizine and home extinction maneuvers, so you send him to the otolaryngologist for further therapy.

You have a productive discussion with Mr. Klein once the consultants' reports arrive, and you somehow make it through the rest of your morning, 60 minutes behind schedule. At 1:10 you head back to your office for a brief lunch break, frustrated and frazzled. You decide to save the pile of unfinished charts for later and, instead, sift through the stack of interoffice memos while you eat.

Although a deliberate exaggeration, this scenario illustrates many of the problems that may be encountered in outpatient practice when critical patient information is not available at the point of care. Physicians in the United States have the knowledge and technology to provide some of the best health care in the world, yet they often are impeded by a host of factors that trouble or complicate the flow of information through the health system [1–3]. Regardless of the setting, few physicians in outpatient practice

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have ready access to all the data that would be useful to them in the care of their patients [1].

Recent Institute of Medicine (IOM) reports cite the lack of an adequate information infrastructure in most health care delivery settings as a major factor underlying extensive and serious health care quality problems in the United States [2–4]. These problems have been defined as *underuse* (failure to provide a health service when it would have produced a favorable patient outcome), *overuse* (providing a service under circumstances in which its potential for harm exceeds its potential benefit), and *misuse* (an appropriate service is selected but the patient does not receive full benefit due to preventable complications) [1]. As physicians increasingly practice within systems of care, the quality of care they deliver is increasingly affected by how well those systems can minimize error and potential harm to patients, coordinate care across the system, and ensure that relevant and accurate information is available when needed [1].

Traditional patient health records are inadequate for meeting the information needs of physicians in practice today. Their original purpose was to remind clinicians of important clinical data and of their own thought processes relative to specific patient care decisions. Over time, patient records have also been called on to serve as legal documents, documentation for billing, a communication system among providers, and a repository of vast clinical data from diverse sources. Unfortunately, paper records fail for many reasons, including poor legibility, missing and misfiled data, lack of detail, and inaccessibility [3]. Furthermore, they are labor-intensive to maintain, require extensive storage space, and are inefficient for retrieving and transferring information [5].

The deficiencies of paper records combined with market pressures to increase clinical workflow efficiency, decrease administrative expense, and improve quality of care are driving the use of computers to support clinical work. While not a panacea, robust computerized patient record (CPR) systems have the potential to help physicians and the systems in which they practice address many of the problems plaguing health care in the United States. Specifically, this technology can support efforts to improve the efficiency of care delivery, increase the provision of services to those who could benefit from them, decrease the provision of inappropriate services, and reduce preventable complications [1–4,6].

Although the medical literature includes many reports on inpatient use of this technology, far less has been written on its application in the outpatient setting. In this article, we focus on the potential for CPRs to impact patient care in the ambulatory setting, drawing on the available literature as well as our personal experience evaluating, designing, implementing, and using CPR systems in an outpatient, multispecialty faculty practice at an academic health center. In addition, we describe the basic functions of outpatient CPRs and offer general recommendations for residents interested in learning about and working with this technology. Finally, the many obstacles impeding realization of the potential of CPR systems are briefly noted and will be further examined in a future article.

How Do Computerized Records Work?

CPR systems are structured repositories of a wide range of patient-specific information not limited by the traditional chronological organization of paper records. As a result, the functional capabilities of CPRs far exceed those of paper records. Some notable examples are described in **Table 1**.

With a database-powered CPR, patient information enters from several sources and is stored in a centralized file that permits simultaneous access by multiple users, while maintaining appropriate security. Using a CPR, clinicians can integrate such functions as documenting patient visits (writing progress notes), ordering and reviewing laboratory and radiologic tests, prescribing medications, billing, scheduling, and communicating with patients. Data can be entered by dictation, by typing directly into the system, or by creating a *structured note* using a mouse or touch screen. Structured notes offer certain advantages, although they also have drawbacks (*see sidebar on page 16 for further discussion*).

Features and Functions

Although hundreds of CPR products are on the market, variation and lack of standardization among software products is such that no one set of features can be found in all systems. The American College of Physicians has produced a useful guide to the various features and functions of current CPR systems [7].

Large vendors often divide themselves between those offering systems that provide comprehensive support for outpatient practice and those offering CPR systems exclusively for inpatient use. A few have designed well-integrated modules for each environment. Outpatient systems typically are referred to as CPR or electronic medical record (EMR) systems. (Note that there is considerable variability in terms used to describe this technology—*CPR*, *EMR*, *electronic patient record*; European authors prefer *electronic health record*. These terms are used interchangeably, with CPR being the

Table 1. Range of Functions of Computerized Patient Record Systems

Basic

Offers structured data entry for medications, diagnoses, and orders
Allows interface with scheduling and billing systems
Provides adequate system availability (around-the-clock access, if necessary)
Allows adequate response time (usually a couple seconds)
Supports multiple office locations, including connectivity between practice sites
Supports multiple users simultaneously
Supports working with multiple patients quickly and safely (sequentially or concurrently)
Supports multiple user access to a single patient record with appropriate security
Offers online user support and technical support
Offers adequate data protection and backups to avoid intrusion or accidental data loss
Allows users to change data fields in various locations of the patient record to support local workflow/templates, so that different specialists can include data for their specialty

Advanced

Allows multiple encounter records on the same patient to be open simultaneously (eg, phone call plus office visit)
Offers evaluation and management (E/M) coding and documentation support
Offers remote access capabilities (eg, from home, emergency department, hospital)
Offers interface options (eg, laboratory, formulary, transcription, radiology), with costs and requirements for these options clear from the outset
Supports midlevel providers and residents in collaborative practice with physicians

Optional

Offers patients secure read-only Internet access to their records (eg, to learn about laboratory results, overdue health maintenance procedures, etc); also offers ability to request appointments, advice, and refills online and avoids insecure e-mail
Allows patients to enter family, social, and past medical history
Allows multiple patient records to be open simultaneously
Supports encrypted e-mail
Provides online access to Web-based patient education materials
Offers e-mail links to the Internet
Provides dial-up support
Provides insurance-specific formulary and referral guidelines

Adapted with permission from American Academy of Family Physicians. Electronic medical record functionality for family medicine. Available at http://www.aafp.org/x2266.xml?printxma. Accessed 11 Nov 2002.

preferred term and the one used in this article.) CPR systems available for outpatient use vary in the features they offer and are somewhat arbitrarily categorized here by the size and complexity of the user group. The simplest software programs resemble an electronic representation of the traditional record. When these programs are enmeshed in a system that provides information management tools (eg, clinical alerts, preventive health reminders, links to medical references, physician order entry tools, communication tools) they begin to be true CPR systems [2,8].

Solo practice. The simplest software programs are designed to organize a single physician's patient data electronically for longitudinal care, allowing the user to enter information and refer to it in managing patients over time, much like paper charts. Although usually based on a desktop computer, these *personal systems* range from software on a handheld personal digital assistant to complex desktop-based systems. Data can be typed into the system (as free text or as a structured note chosen from a form-based menu system) or dictated and transcribed. Voice-recognition technology can be used to enter notes in the free text or template format. Personal systems usually support a problem list, medication lists, and progress notes, and they may include Internet access to Web-based resources, e-mail,

Benefits and Limitations of the Structured Note

Computerized patient record (CPR) systems allow patient data to be entered as plain text or as a *structured note*. The latter option employs an input template that forces the user to enter key pieces of information using standardized words or phrases that carry a specific meaning in the system. The meaning of these terms can span a spectrum of medically useful concepts.

To illustrate how a structured note is created, consider, for example, that one of your patients reports an allergy to amoxicillin. You would enter this information into an input template by first clicking on the term *allergies* and then picking the term *penicillins* from a list of predefined allergies, which enters the selected allergy into a database. As a result, the CPR system now "knows" your patient has an allergy to penicillins. If you had typed or dictated this information as part of a plain text note, the system would not be able to associate the word *amoxicillin* with the concept of *allergy*.

By using standardized terms, structured notes offer certain advantages over plain text notes, such as allowing users to incorporate patient-specific, knowledge-based decision aids and prompts. For example, continuing with our patient scenario, suppose that 3 years after you wrote the structured note your patient needs antibiotic therapy for strep pneumonia, and you feel the best choice would be penicillin G. Because your CPR uses structured text input and has a database that now associates *penicillin* with *allergy* in this patient, when you try to write the prescription using the CPR, a warning pops up, indicating the possible contraindication due to the preexisting allergy. This warning will be given even if the prescription is written by a colleague who is covering for you and was not informed by the patient about the allergy, because the structured note you wrote 3 years earlier remains in the system. If, however, the CPR does not permit the recording of structured text and all that exists is the allergy notation in a note from 3 years ago, the system will not generate a warning that a penicillin G prescription is potentially life-threatening to this patient.

Use of structured notes can also facilitate easier searches and manipulation of data in a CPR system. For example, structured notes that are associated with specific diagnostic and procedural codes can aid with billing and can enable a search for duplicate codes indicating multiple instances of the same laboratory test being ordered. The extent of text that is structured in the CPR varies according to the software used and the user's preferences. Note, however, that it is equally applicable to the inpatient and outpatient settings.

The downside of structured text entry is that it forces users to adapt their data input to fit a preexisting template for the clinical scenario. Although many templates exist for different specialties and clinical settings (eg, new patient visit, return visit), it is impossible to devise a template that can encompass all the clinical scenarios that the average physician faces every day. Early attempts to capture 100% of clinical information using templates failed because of this. It is currently believed that a mixture of structured text (using templates to capture essential information needed for effective decision support) and plain text (using dictation to fill the gaps not addressed by the templates) is most practical for clinical practice, while achieving the advantages of having critical structured text information in the CPR.

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and instant messaging. However, there is limited ability to import data from external sources, such as laboratories. Also, these systems may or may not offer prescription writing and drug-interaction checking.

Clinical department or small group practice. Designed to support fewer than 10 users, a *departmental system* usually has more features than a personal system and is appropriate in a setting where users share terminology and billing codes (eg, division of gastroenterology, small single-specialty practice). A local area network (LAN) is needed to connect providers and office staff. Once connected on a LAN, users of the CPR system can simultaneously share patient information and *workflow* (ie, routing documents between users to facilitate processing patient requests for prescription refills, referrals, and advice). Many systems add a specialized computer on the network to hold files (a *file server*) and workflow software to route documents between users. This allows users to share information entered by others or transmitted to the system via outside data sources such as laboratories. A nurse can see a physician's last note immediately to answer a phone call without pulling a chart. Security concerns and cost factors begin to come into play with such system capabilities. Also, users must agree to some uniformity in defining the data entered into these systems and to how it is entered, so workflow can be efficient. With common terminology definitions, users are assured of understanding data regardless of who entered it. Although the result is improved data capture and workflow, changing the way individual physicians are accustomed to working may be easier said than done.

Large multispecialty group or single hospital. The added complexities of multiple specialties and inpatient care demand a more elaborate *enterprise-wide system* that incorporates sophisticated features needed for increased security and performance, allowing a large group practice to operate as a single entity rather than a collection of specialty departments. With such systems, a primary care physician can refer a patient to a specialist in the group and send the specialist a link to her last full visit note, without needing to recreate a summary on a referral form. Similarly, the specialist can avoid writing a formal letter to the referring physician, because his office note is visible in the CPR. If the primary care physician is not sure the referral is needed, with the patient's permission, the specialist can simply review the patient's record and give the primary physician an electronic *curb-side consult.* Many systems will establish an electronic link with laboratory, radiology, and dictation services to import electronic data such as test results, imaging reports, transcriptions, and even images. With these advanced features, security, cost, and coordination among departments become larger issues. These systems involve database servers on the network to provide information to hundreds of users at the same time, keeping track of who looked at which patient's record. The recent requirement for compliance with the Health Insurance Portability and Privacy Act (HIPAA) adds the cost and complexity of a dedicated information technology staff, including a HIPAA privacy officer to prevent inappropriate access to patient health information.

Integrated delivery system. A *regional* or *multi-enterprise system* may span several institutions and physician groups across inpatient and outpatient settings, bringing together all aspects of patient care and allowing information to follow patients over time (eg, from outpatient registration and care through hospitalization and rehabilitation). These overarching systems integrate with the single enterprise system and often provide secure physician-patient and physician-physician communication. One advantage is that a physician at any participating institution can access information about a patient who receives care elsewhere within the delivery system. Having patient information flow between disparate health care facilities can be life-saving for complex patients who must visit an emergency department away from their usual source of care, but within the reach of another participating institution. Because patients visiting different enterprises over many years may give different and conflicting information to each system, a *master patient index* calculates a probability that a given person presenting for care is a new patient or a person already represented in the CPR system. The information is stored in a special database, where it can be viewed through a Web browser by all properly authorized physicians. For multi-enterprise systems to succeed there must be uniformity among the different enterprise systems; a data dictionary is used to coordinate the terminology from the disparate systems. Also, all participants must agree on a governance structure and on who will store this information, and they must overcome proprietary concerns about losing patients from their particular health system. Security concerns increase as the network becomes a bigger target for electronic intruders. Costs, while shrinking on a per-patient basis due to economies of scale, increase in absolute amount and can be an insurmountable obstacle to implementation. Due to significant barriers that must be overcome, multi-enterprise systems are not available in most places.

A Word about Application Service Providers

In most of the systems described, the assumption is that the hardware is owned and maintained by the involved physicians and practices. For larger practices, this is cost-effective. For smaller practices, an *application service provider* (ASP) may be an attractive alternative because it can offer a sophisticated system at a significantly lower cost on a monthly subscription basis. In this scenario, the ASP purchases hardware and a license to an expensive, feature-loaded CPR system, which the practice connects to with a Web browser. The practice does not need to hire information technology staff or put up large amounts of money for hardware and software. The servers and software are maintained and updated by the ASP.

Using Computerized Records: An Illustration

Returning to the opening scenario and imagining patient care supported by an integrated CPR system, your morning seeing patients at a large multispecialty outpatient practice might play out as follows:

You are a general internist in a large multispecialty faculty practice that 1 year ago completed phasing in a CPR system. Tonight, while on call, you use the system to obtain past history on one of your partner's patients and give her appropriate advice.

The next day begins with a visit from Ms. Saracino, who presents for regular follow-up for her diabetes. You greet her in the exam room and sit so both of you can see the computer that is in the room. Using the CPR, you review results from Ms. Saracino's laboratory studies, which were performed yesterday. You inform her that her results indicate she is in compliance with the American Diabetes Association guidelines for blood sugar control, which pleases her. Continuing to use the CPR, you refill her medications and fax the refill order to her pharmacy with the touch of a button. You also generate an e-mail to be sent to her next month, reminding her to come in for her annual flu shot, and print an information sheet on taking insulin correctly for her to pick up at the nurses' station on the way out. Noticing your previous visit notes, you take a moment to inquire about her horse and ask whether she is still riding regularly.

Next, you review Mr. Klein's consultations and decide to try eradication of his *Helicobacter pylori* prior to proceeding with surgery. You briefly look at the material he brought from the commercial Web sites he found and give him a link to your favorite patient education site for GERD.

Between patients you easily handle patient calls for referrals and medication refills and do a literature search on treatment for a patient with Zollinger-Ellison syndrome. Before Mr. Henderson arrives you quickly review his record and decide to send him to the otolaryngologist. This allows you to use the visit time to discuss how he and his wife are being affected by his Alzheimer's disease. You tell them about a Web site that describes day programs in their community, where Mr. Henderson can spend some time in a structured environment, giving Mrs. Henderson a respite. You mention that the site also has links to studies showing better outcomes for caregivers who take advantage of day programs. Because the couple does not have access to a computer, you ask the nurse to print the relevant information for them so they can take it home to review.

You spend no additional time on billing and finish your morning schedule on time, feeling energized that you connected with your patients, learned something new, and made a difference. It's good to be in medicine.

How Can Computerized Records Improve Outpatient Care?

With its many functional applications, CPR technology represents a potential tool for helping individual physicians and health systems improve the quality and efficiency of the health care they provide (**Table 2**). CPR systems can help ensure access to complete, accurate, and timely information about the health services needed or received by patients, thus supporting the delivery of optimal care at both the individual patient and population levels. Specifically, these systems offer users the ability to 1) gather and analyze important patient-specific information at the point of care, 2) examine and better manage the health of a population (eg, by searching for all patients who would benefit from a preventive or therapeutic intervention), and 3) track clinical processes and outcomes of care. Whether this potential is realized depends on overcoming several important obstacles that currently impede the widespread use of CPRs in practice. These important limiting factors are briefly described in **Table 3**.

Promise #1: Better Quality of Care

Improved documentation. Physicians in paper-based office practice often are challenged to plan the appropriate next step in a patient's care because the historical record is missing, misfiled, disorganized, incomplete, or illegible. For example, a 1994 report found that physicians in an academic internal medicine clinic could not find at least one piece of patient data in 81% of cases [9]. The data were either missing from the chart or could not be found in a reasonable period of time due to misfiling. In another study, physicians in an oncology practice spent 12% of their daily activity retrieving information relevant to patient care while their medical office assistants spent 23% of their time accessing patient-specific information [10].

CPRs are well suited to address these problems because they facilitate accurate, complete, and legible documentation about each patient encounter, which is readily accessible from that point forward. By using templates or form-based data entry, some systems prompt users to document pertinent information based on the diagnosis selected. Many systems offer a summary screen that shows such information as the reason for the visit, current diagnoses and medications, recent visits in the health system (eg, to an emergency department or other clinician office), and upcoming appointments or health interventions that are due. With this knowledge, the physician is better able to

Table 2. Promises of Computerized Patient Record Systems

Improve quality of care

Reduce incidence of errors

- Ensure progress notes and prescriptions are complete and legible
- Cross-check prescriptions and alert to errors related to dosage, allergies, comorbid conditions, laboratory results, other medications
- Provide "just-in-time" drug information and links to relevant guidelines
- Provide relevant patient education materials

Promote compliance with evidence-based best practices

- Provide "just-in-time" links to relevant guidelines
- Prompt patient-appropriate health interventions (preventive, therapeutic)
- Facilitate more precise and accurate practice profiling

Improve efficiency of care delivery

Save time and costs

- Provide access to patient information when and where it is needed
- Automate transmission of prescriptions and refills to pharmacies
- Facilitate formulary compliance
- Reduce duplicate testing (overuse)
- Avoid costs of dictation, chart duplication, paper file storage

Facilitate more accurate billing and improved reimbursement

- Automate coding with structured notes
- Eliminate billing delays
- Provide accurate, complete documentation of encounter data

Facilitate physician-physician communication

- Simplify communication related to referrals and consultations (consultant and primary physician can see each other's notes)
- Consolidate patient data in one accessible location

Facilitate physician-patient communication

- Ensure secure messaging
- Provide prompt appointment and preventive care reminders
- Provide customized patient education materials and trended health data

Promote clinical research and education

Facilitate process and outcome measurement

- Structured data easily queried to identify patients, risk factors

Facilitate teaching, supervision, and evaluation of students and residents

- Provide embedded guidelines and decision support
- Review notes and test results
- Follow documentation of patient phone calls and response

place a specific visit in the broader context of the patient's overall health needs and to address any immediate concerns.

Studies have found that using CPR systems in inpatient settings improves the completeness and accuracy of patient records [11] but often at the cost of much greater time spent in documentation [10]. Although the effects on documentation in the outpatient setting have not been completely studied, anecdotal reports suggest similar findings: while using CPRs does take more time, the result is more complete and better documentation [12].

Fewer medication-related errors. In 1999, the IOM released a landmark report calling attention to the large number of medical errors that occur in the United States, with resultant patient harm [2]. Although the exact number of patients who are hurt or die as a result of medical errors is debated, it is clear that these events occur more commonly than they should [13]. Particularly well documented in the literature is the occurrence of medication-related errors, which have been studied extensively over recent years. Commonly identified factors leading to medication errors include inadequate knowledge and availability of important patient information, lack of knowledge of the drug, prescribing rule violations, and slips and memory lapses [14].

The combination of CPRs and computerized physician order entry (CPOE) tools is an important way that information technology has been used to facilitate more accurate medication prescribing and reduce medication-related errors [15–17]. Errors can be reduced and the quality of care enhanced by the CPR system's interaction with three databases: 1) the patient's medication history, 2) other patient-specific data (eg, age, diagnoses, allergies, weight, relevant laboratory results), and 3) a scientific drug information reference and guideline. Prior to selecting a medication on a CPR system, a physician can access prescribing information such as guidelines for drug use, information about proper

Table 3. Obstacles to Implementing Computerized Patient Record (CPR) Systems

Analysis problems

- Evaluating practice needs and prioritizing conflicting needs is difficult
- Selecting a CPR product is difficult when none is perfect for the practice
- Compromise between political factions does not come easily
- Scope of project increases unaccountably during system implementation

Cost factors

- Hardware must be expanded to new (clinical) areas of use
- Software licenses must be acquired for operating systems and office suites for new areas of use
- Expenses frequently balloon unexpectedly
- More IT staff needed for maintenance, user support, and help desk functions

Change management problems

- Transition to CPR environment often requires extensive change in physician workflow and routine (change is difficult)
- Extensive initial and continued training is needed
- CPR systems require changes in people who do not benefit from the computer but who must interact with it to benefit others (eg, clinical support staff entering vital signs)
- Slow or incomplete transition from paper to CPR system causes increased overhead expense and confused work-flow while using both systems

Time problems

- More initial time input by physicians often required to benefit whole practice
- Implementation often takes longer than projected

Security and confidentiality concerns

- HIPAA compliance must be ensured
- Corporate climate lax on security (eg, shared passwords)
- Concentration of information makes CPR system a bigger and more profitable target for illegal intrusion

Information architecture problems

- Laboratory data to be interfaced must be translated to common standard units and definition
- Patients must be unambiguously identified by automated interface systems in real-time to facilitate rapid data import
- All contributing systems must use common definition of health care terms

Software inadequacy

- Software does not conform to standard defaults and expected behavior of operating system
- Software not designed with efficiency of physicians in mind (click count too high)
- Software does not perform with sub-second or task-appropriate response time
- Difficult to switch tasks and preserve existing progress when interrupted
- Screen layout and button function not intuitive, must be memorized
- Software allows users to make errors without warning

HIPPA = Health Insurance Portability and Privacy Act; IT = information technology.

dosage and possible adverse reactions, and formulary guidelines. As the medication order is entered online using a CPOE tool, the CPR reviews it for problems, and when the order is printed or transmitted it is legible. Many CPR systems also incorporate patient education material on prescribed medications, which can be given to the patient with the prescription.

Greater compliance with evidence-based best practices. Much has been written about inappropriate variations in the delivery of health care services in the United States (eg, overuse of certain diagnostic and surgical procedures, underuse of proven effective therapeutic agents) and the adverse effects that clinical practice variations can have on patient populations, insurers, employers, and society [18]. These problems continue to be reported, despite internal and external pressures on providers and health systems to comply with evidence-based best practices. For example, the National Committee for Quality Assurance reported that in 2001, 66% of adolescents were not adequately immunized and that 25% to 45% of adult women were not adequately screened for breast cancer [19]. In the course of providing patient care, physicians often need additional information regarding diagnostic and treatment strategies [20]. Covell [21] found that only 30% of such information needs are met during the patient visit due to the difficulty in quickly accessing up to date information. One study of a large academic medical center found that 77% of physicians reported having no reliable method for identifying patients overdue for any

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required follow-up testing [22]. In most outpatient settings, information systems simply are not equipped to identify patients due for routine health maintenance interventions, to track patients who miss a scheduled appointment or diagnostic test, or to provide ongoing information, reminders, and support to patients with complex courses of treatment [23].

A compelling argument for the use of CPRs is their potential to prompt delivery of patient-appropriate, evidence-based health services and to track physician performance of these services. For example, with a comprehensive CPR system, patients due for preventive screening or interventions such as mammography or influenza vaccination can be easily identified and contacted. In different studies, the use of system-generated reminders resulted in 8% to 34% increases in immunization rates and up to 47% improvement in the performance of preventive tasks [24]. CPRs also can prompt timely and appropriate diagnostic and therapeutic interventions. In addition to providing ready access to patient-specific clinical data—including summaries or graphs of trended health data (eg, weight, blood pressure readings, cholesterol values, blood glucose measurements)—a CPR can facilitate medical decision-making at the point of care by providing links to relevant evidence-based practice guidelines as orders are being written in the system. Strong evidence suggests that such computer-based decision-support systems can improve physician compliance with clinical practice guidelines for preventive and therapeutic care [25].

Although the medical literature clearly supports a beneficial effect of CPRs on patterns of care [26], data on how they affect patient outcomes is sparse. A cross-sectional survey of clinicians after implementation of a CPR system found that most clinicians felt that the CPR had improved the overall quality of patient care [27]. Advanced CPR systems can facilitate outcome studies, and it is imperative that these studies be performed as this technology disseminates.

Promise #2: More Efficient Care Delivery

In addition to promising better quality of care, CPRs have the potential to increase practice efficiency and reduce the costs of care delivery [5,28].

Time and cost savings for a practice. Although not immediately realized due to acquisition and training costs, over time a CPR system has the potential to reduce costs and increase revenue. Time motion studies of outpatient practices have shown that CPRs can result in savings by reducing manual functions, eliminating paper charts, reducing physician documentation time [28], reducing redundant testing, and decreasing the need for photocopy and faxing services [5,29]. Decreased time for documentation is further supported by studies of hospital-based CPR systems, which suggest that nursing staff overtime is reduced due to decreased documentation time [30]. Multispecialty group practices can avoid the costs associated with maintaining duplicate medical records for a patient in different departments of the group.

The promise of ready access to more accurate and complete documentation means less physician time spent searching a chart for essential information or waiting for a chart to be found as well as greater assurance that decisions are based on reliable information. With most CPRs, critical patient data (eg, current medications, recent history, study results, formulary and other insurance-related information or requirements) can be readily accessed when and where it is needed, allowing faster analysis of all data needed to make clinical decisions. Some systems also enable a physician on-call in the hospital or at home to access critical patient information, thus avoiding the possibility of ordering duplicate tests or admitting a patient unnecessarily. By making patient information available as needed at the point of care and saving documentation time, a CPR can enhance physician productivity and revenue generation [28,31].

More accurate billing. Better documentation of encounter data via a CPR also means more accurate billing for services received by patients. Structured note writing (*see sidebar on page 16*) can link to billing so that as a note is written, the diagnostic (ICD) and procedural (CPT) codes are incorporated into the bill for the visit. As a result, the physician does not need to complete a separate billing form. Structured note writing ensures that documentation supports the level of service billed and improves charge capture (ie, more correct charges billed, fewer incorrectly coded charges bounced back), because the charges are submitted as the encounter note is generated [31]. Because billing can be electronically linked to the generation of an encounter note, residents and attending physicians can spend much less time learning the minute details of coding and billing procedures. Updates to the CPR system can incorporate revised coding and billing information.

Streamlined prescribing. Refilling medications electronically in a CPR saves physicians countless hours writing prescriptions by hand. Additionally, transmitting prescriptions directly to the pharmacy saves time, reduces the potential for error, and meets patients' needs faster. CPRs also can facilitate prescribing of generic and formulary drugs when appropriate; as this practice increases, prescribing costs decline in managed care settings [24].

Promise #3: Promote Research and Education

Facilitate process and outcome measurement. When patient information from clinical encounters is incomplete, poorly organized, unreliable, or difficult to access, observations of the processes and outcomes of care are cumbersome to undertake. By capturing complete and detailed clinical information about a population of patients over time, CPR systems have the potential to facilitate epidemiologic studies, outcome research, and clinical process management [32]. In fact, any research that relies on data recorded in routine medical practice would be more possible using CPR technology [33]. For example, a health system could readily undertake an outcome study looking at glycosylated hemoglobin levels as a measure of how well type 2 diabetes is being managed in a defined population of patients whose levels are being tracked in a CPR. Or, physician performance relative to a current clinical practice guideline could be measured, as suggested by a recent study using a CPR system to spot physician practice patterns that did not comply with national guidelines for secondary prevention of hypercholesterolemia [34]. Additionally, patients could be readily identified for studies by searching the CPR for patients who meet inclusion and exclusion criteria. It is important to note that detailed search queries for epidemiologic and outcome studies require that the data in the system be entered in a coded format. Such structured data entry is only available in advanced CPR systems and represents a significant departure from traditional physician workflows. It remains to be seen whether this will be an impediment to using these systems for research.

Support resident education. CPRs have the potential to support resident education in several ways. For residents, using a CPR system would allow ready access to outpatient information when patients are hospitalized and make it easier to answer patient calls and to follow up on laboratory results for clinic patients while on hospital rotations. With a CPR system, handing off clinic patients to new residents at the end of the year or signing patients out when residents are on vacation could be more efficient and effective. The CPR also offers an ideal vehicle to support quality assurance projects undertaken by house staff.

For physicians who are supervising and evaluating residents in clinic, a CPR system would make it easier to review and sign notes and to oversee important patient care that continues after the clinic visit. The information in a CPR system also can facilitate teaching evidence-based practice to house staff and students. For example, at the Michigan State University, Zaroukian, Weismantl, and Sousa are in the process of implementing the "MSU Virtual Practice," an educational strategy that uses a CPR system populated with simulated patients to teach and assess students in the competencies needed to deliver evidence-based patient care while simultaneously making them competent CPR users [M Zaroukian, written communication, September 2002].

Are Computerized Records in Common Use?

Compared with other technology advances offering improvement over existing methods of practice, innovations in information technology have not been embraced by the medical profession. For example, computed tomography, magnetic resonance imaging, and positron emission tomography have gradually worked their way into the mainstream of diagnostic care because vast improvement is evident over results obtained on plain film radiography or pneumoencephalography. Cardiologists have used increasingly sophisticated pacemakers and implantable defibrillators because their use has shown statistically and clinically significant improvements in outcomes. Yet, despite being available for more than 20 years, CPR technology has not been widely adopted by practices.

Much has been written on the reasons for this slow adoption [35–37]. The lack of a universal standard for data and concept definitions in the health care field and inadequate consideration of human factors are two reasons that CPR systems have not had more widespread appeal. The dismal financial climate of most medical practices and the high initial costs and delayed benefits also explain the lack of penetration into practice. Table 3 lists some of the obstacles to implementing CPRs.

Data on current use of CPRs is scarce in the literature, but two recent physician surveys suggest that this technology is used by a minority of those in active practice [38,39]. Of the 687 members of the Indiana Academy of Family Practice who responded to a survey about physician use of and attitudes about CPRs, only 14% reported they were using a CPR [38]. A national survey of all U.S. family practice residency programs, performed in 1998, produced similar results: of the 329 programs that responded, 17% reported using a CPR system and another 3% had tried a CPR but retreated from its use, with software inadequacy cited as the most common factor leading to discontinuation of CPR use [39]. Using the results of this second survey as a basis for predicting future use, the authors estimated that 43% of family practice programs would be using a CPR in 2000 [39]. While these estimates have

Table 4. Web Sites Offering Useful Information About Computerized Patient Record (CPR) Systems

Site/Source	Web Address	Description
ELMR	http://www.elmr-electronic-medical-records-emr.com	Offers a primer on CPRs and a matrix of more than 70 programs available for small offices, with links to vendor sites for product information. Updated as recently as 17 October 2002.
Electronic Medical Records: The *FPM* Vendor Survey	http://www.aafp.org/fpm/20010100/45elec.html	Full text review article from *Family Practice Management*, based on vendor survey conducted in 2000. Includes useful background and educational material. As with everything in technology, time moves on and creates obsolescent information, so consider this a useful snapshot of a few years ago.
Digital Physician	http://www.electronic-medical-record-software.com	Provides online comparison of 75 CPR software programs (cost is $19.95 for access to a database of CPRs with selected features).
Computing for Clinicians	http://www.computingforclinicians.com	Offers a list of products with vendor links, a bibliography, and related links to help survey the field.

not been born out in practice, CPRs are used by thousands of physicians across the United States, including physicians at several academic health centers. There tends to be greater use of CPRs in new family practice residency programs and family practice programs with fellowships; no geographic trends in CPR use or trends among university-affiliated programs have been noted [39].

What Should I Do If I Want to Use Computerized Records?

Physicians entering practice who want to use CPRs for patient care need to consider several factors. If you plan to join an existing group that has a CPR system already in place, it is important to ask probing questions about how the practice uses the system, what the system is equipped to do, and how well the system is accepted by current physicians and staff. If you choose to start a new practice—whether alone or with others—this is clearly the best time to incorporate computerized patient records. When starting from day 1, especially if alone or with a small number of like-minded individuals without an entrenched practice workflow, the many systems that can automate a practice can be most easily compared. Retrofitting a CPR system into an existing solo or group practice can be a challenging, expensive, and drawn-out affair.

A common mistake physicians make in trying to select a system is to ask, "What is the best CPR system on the market?" Every practice has a unique set of needs that should dictate what CPR system and features are selected. For example, consider the various ways to input encounter data into notes. One practice that uses dictation might fit perfectly with a certain CPR system, whereas another practice heavily involved with research would be unable to mine individual data elements from transcribed text and would, therefore, get little value from the same CPR. The research practice might do well with a system that requires structured data entry using electronic forms and coded data elements. This would permit querying the data from the many perspectives necessary for research studies. On the other hand, the dictation practice might suffocate with structured, coded data entry because it can be more time consuming and does not enhance the practice.

Another important mistake physicians make in judging a CPR system is to focus on the software and hardware components and to underestimate the role that human factors play. Physician reluctance or refusal to use a CPR for patient care, for whatever reason, can sink a project no matter how good the software product. Alternatively, a mediocre product embraced by physician leaders and supported by the administration can revolutionize a practice. If you are considering joining a practice that has a CPR system in place, ask how the system was chosen and who had input. The answers will tell you if this is generally a democratic practice or one run by administration without adequate physician input. You should also ask what the primary goal was in choosing a CPR (eg, to save money or time? to improve the quality of care?). Finally, you should know whether your productivity expectations in the practice take into account time to learn how to use the CPR system.

Other questions to consider when thinking about using a CPR include:

- Do I want to dictate all my notes?
- Am I willing to use a computer in the exam room, and will my patients accept a computer?
- Is the ability to perform detailed data queries of medications and diagnoses worth the added effort of structured data entry?

Your answers to these questions will tell you more about whether a given CPR system is right for you and your practice than will knowing the quality of the system's software code. No system is inherently right or wrong for a given practice. Hardware is relatively standardized and can essentially be taken out of the equation for all but the largest systems. **Table 4** lists a few Web sites offering useful information about CPR systems.

Conclusion

Many ills currently plaguing health care delivery must be remedied if physicians of the 21st century are to provide the highest quality care to their patients in a cost-effective and efficient manner. Fully developed CPR systems promise to support efforts to cure many of these problems. Residents should learn as much as they can about this promising technology so they can integrate it successfully into their future practices.

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