Use and Adoption of Computer-based Patient Records

Prepared for:

California HealthCare Foundation

Authors:

David J. Brailer, M.D., Ph.D.,
Health Technology Center

Emi L. Terasawa, A.B.,
CareScience

October 2003

About the Author

Dr. Brailer is Senior Fellow for Information Technology and Quality of Care at the Health Technology Center in San Francisco.

About the Foundation

The California HealthCare Foundation, based in Oakland, is an independent philanthropy committed to improving California's health care delivery and financing systems. Formed in 1996, our goal is to ensure that all Californians have access to affordable, quality health care.

ISBN 1-932064-54-0

Contents

Executive Summary

MUCH ATTENTION HAS BEEN GIVEN TO THE adoption of computer-based patient records (CPRs) in hospitals, physician offices, and ancillary care sites. Over the past decade, many reports have been issued estimating the use and rate of adoption of CPRs. Many have analyzed the factors that influence adoption of CPRs to promote their use. These reports and analyses provide the basis for substantial policy debate about how to stimulate CPR adoption, and are often used to measure the impact of such policies.

However, the assumptions about CPR adoption that drive public and private policy are often based on inconsistent and incomplete information. Although multiple studies have been performed, their findings have been dissonant, and their methods are unscientific. Some critical information is missing entirely. Since these studies are nearly all based on retrospective, non-random, subjective recall surveys, there are limitations on the ability to draw meaningful conclusions from this work or to use them for policy development or evaluation.

The industry also lacks a commonly accepted set of definitions and terminology for clinical information tools, with terminology ranging from "automated medical record" to "virtual patient record" to "electronic medical record." There is also disagreement about what functions should be considered part of a CPR.

Given these limitations, it is possible to make some observations about CPR adoption, use, and standards:

CPR Adoption Rates

- While few studies have measured CPR use in hospitals, there are more data about a subset of CPRs, computerized physician order entry (CPOE). Adoption rates for CPOE ranged from 3.3 percent to 21 percent in various surveys. The lack of consistency of these findings is a hindrance to policymakers or other meaningful uses of this data.
- CPR adoption in physician offices has been more widely surveyed. The most consistent findings suggest a use rate of 20 percent to 25 percent of practices using CPRs now and 50 percent to 60 percent in the near future. If these data are accurate, they could indicate that physician office CPRs are becoming more widespread than inpatient CPRs.

Factors Influencing CPR Adoption

- There remain strong drivers pushing health care organizations toward adoption of systems. Paramount is the need to share patient data among different sites and among clinicians for improved quality of care.
- Larger organizations and those in urban markets are more likely to adopt CPR than smaller and rural organizations.
- The greatest barriers to CPR adoption are lack of funding and resistance by physicians, which are not often seen as inter-related problems, but which appear to be two facets of the same problem—uncertainty for any organization about the specific benefits they will derive from the large and the multi-year investments needed for CPRs.

Adoption of Standards

- Lack of interoperability among health care information systems is of little concern to most CPR buyers, although interoperability is an important factor in making CPR cost-effective, useable, and clinically beneficial.
- There are low adoption rates for some standards that are critical to interoperability, such as unique patient identifiers and standardized codes. More research needs to be done on the ways to understand the factors that will lead to demand for these by hospitals and physician groups.

Observations and Discussion

Overall, it seems that the use of CPRs is growing and will likely continue to grow. However, the issue at stake is not whether CPR use is growing, but whether the adoption of this technology will improve the health status of Americans. This issue relies upon three questions:

- Whether CPR adoption is growing at a sufficiently fast pace;
- Whether adoption disparities will create two tiers of care; and
- Whether CPRs will be interoperable or stand alone.

Policymakers need to recognize that very little is known about the true rate of adoption of CPRs and interoperability standards. Public policy would benefit from an objective and rigorous longitudinal survey of CPR and interoperability standards adoption that covers all relevant sites of care.

The remedy to the largest barrier to CPR adoption—financial resources—may lie in reducing the second barrier, physician resistance. Policy must consider how to enable CPR buyers to support physician adoption of CPRs, which in turn will make the financial case for CPR adoption stronger.

There are separate concerns about the growing CPR adoption gap between large, urban organizations and their smaller, non-urban counterparts. The United States is at or very near a two-tiered system of care based solely on CPR capabilities. Regional CPR support organizations could be useful for small and rural hospitals or physician groups.

Policy attention should be given to the question of whether accelerating standards adoption can be a catalyst to overall CPR adoption. That will require making a clear case for how interoperability changes the daily work of physicians, patients, and others in health care in a positive manner.

I. Introduction

MUCH ATTENTION HAS BEEN GIVEN TO THE adoption of computer-based patient records (CPRs)[1] in hospitals, physician offices, and ancillary care sites. Over the past decade, policy and industry groups, investment analysts, and government agencies have issued reports, surveys, and projections about the use and rate of adoption of CPRs. Many have analyzed the factors that influence adoption of CPRs to promote their use. A growing number of network participation requirements, private and government payer reimbursement policies, and internal budgets are based in no small part on published studies forecasting the near-term inevitability of CPRs. Moreover, substantial policy debate has risen around how to address CPR adoption because of these reports, and these reports are often cited to demonstrate how a given policy effort has succeeded or failed.

However, the assumptions about CPR adoption that drive public and private policy are often based on inconsistent and incomplete information. Although multiple studies have been performed, their findings have been dissonant, and their methods are unscientific. Some critical information is missing entirely. Many studies have been produced by organizations with explicit pro-adoption views, but the degree of bias in these studies remains undefined. Nevertheless, the general optimism generated by these studies has had a growing impact on public policy and health system budgets.

Summarized here are the published reports about the adoption of CPRs by hospitals, physician groups, and ancillary care sites. This cohesive summary of studies may help clarify the debate so that public policy discussions can be based on reasonable facts about what and how CPRs are being used. Since these studies are nearly all based on retrospective, non-random, subjective recall surveys, there are limitations on the ability to perform rigorous analysis of this work. Therefore, the findings have been compared at face value to draw whatever observations are possible from the overall composite of the studies.

II. Overview of Computer-based Patient Records

THE INDUSTRY LACKS A COMMONLY ACCEPTED set of definitions and terminology for clinical information tools. In fact, many different terms are used throughout the literature to describe CPRs. These terms include:

- Automated medical record (AMR)
- Clinical data repository (CDR)
- Computer-based patient record (CPR)
- Computer-based patient record system (CPRS)
- Computer-based patient record-type system (CPRS)
- Computerized medical record (CMR)
- Computerized patient record (CPR)
- Electronic health record (EHR)
- Electronic medical record (EMR)
- Electronic patient record (EPR)
- Lifetime data repository (LDR)
- Virtual health record (VHR)
- Virtual patient record (VPR)

A number of articles were reviewed in which authors use elaborate efforts to differentiate these labels. There did not appear to be a meaningful way to differentiate these terms into classes of tools that were useful to segment and refine this analysis. Undoubtedly, the confusion inherent in the classification of CPRs contributes to conflicting information about whether these tools are used by clinicians, how they are used, and what influences their use. It is difficult to estimate the degree of this error but likely it is significant and potentially harmful to the effort to understand CPR adoption. (The term computer-based patient record (CPR) is used throughout this paper to refer to information tools used in a clinical setting.)

Of greater importance than general nomenclature is a broad disagreement among prior authors about the core components of CPRs. One of the central issues that underlies the confusion and ambiguity about the status and adoption of CPRs is that the components of these technologies have arisen more from arbitrary vendor marketing than from well-defined classifications. Most efforts to assemble and characterize CPR functions have reflected this ambiguity, which hurts policy efforts to stimulate CPR adoption.

Six authoritative topologies of CPRs were identified[1] that have been published in the past decade about CPRs in hospitals and physician offices.[2] It should be noted that these six do not agree on the classification of CPR elements, but they were selected because of the specificity of their definitions and their exhaustive effort to classify CPRs. These are summarized in Table 1. In this report, Peter Waegemann's functional topology of CPRs was used as a frame of reference in which to categorize the other frameworks. It provides the most modern CPR functional categorization.

Table 1. Topologies of CPR Functions

Waegemann 2002	BPHC, 2002[2]	Rehm and Kraft, 2001	Dick, Steen and Detmer, 1991	CPRI, 1996[3]	Tang and Hammond, 1991
Recording information	Data capture (data elements, entry devices, data import, data definition, input)	Data capture (data elements, entry devices, data definition)	Storage	Data capture (sources of data, entry devices, data import, data definition)	Integrated view of patient data
Accessing information	Data access (search, accessibility, security)	Data access (search, accessibility, security)	Access	Storage functions and information presentation	Data access
Order entry	Order entry	Order entry	Order entry	Information processing (comprehensive record of care, patient care processes, administrative processes)	Physician order entry (clinician data entry)
Decision support	Practitioner Support (clinical decision support, clinical registries, alerts, clinical practice guidelines, quality assurance, cost measuring)	Practitioner Support (records management, case management, clinical decision support, administrative reports, CQI and COPC)	Practitioner Support (clinical decision support, data analysis, information management, implementing quality and cost policies)	Operational processes; related data and knowledge bases; legal and administrative characteristics	Clinical decision support; access to knowledge resources
Sharing of information and Interoperability	Communication Features; Interoperable	Communication Features	Connectivity	Information (interoperability, integration of data across multiple sites, communication protocols)	Integrated communications support
Unique patient Identification		Identification	Identification		
Security and Authentication			Security	Security functions, access control, data protection integrity	
Auditing	Patient Features (educational resources)	Patient Feature (reminders, access to personal data, educational resources)			
	Validation	Validation	Validation	Validation	

These authors have some areas of agreement, including required CPR functionalities for recording information, accessing information, entering orders, and decision support. There is also agreement that CPRs should have sharing and interoperability functions, although most of what was described by these authors is focused on within-system integration rather than cross-enterprise or community-level integration. Also, although all authors denote some form of order entry, some do not specify whether this is physician-entered (e.g., CPOE), which is now getting substantial attention, or entered by a clerical person, which has been the norm in the past.

There are five areas in which the authors do not agree or are silent on whether the function should be considered part of the CPR. They are:

Unique patient ID. This is the capability of generating or enforcing a unique patient identifier. This is a critical dependency for full utilization of the CPR as a quality improvement tool, but these authors disagree about whether this functionality is external to CPR functionality (i.e., is supplied by core administrative systems) or is required within the CPR.

Security and authentication. These functions refer to a substantial set of technologies that ensure protection of data access, enforcement of user verification, encryption, and other technologies. Security and authentication are areas of rapid change in both operating expectations and technical capabilities. Some authors consider this a required component of CPRs while others do not address it.

Patient support. This function refers to capabilities of the CPR to provide information access to patients, foster physician-patient communication, support patient education, and potentially manage informed consent. Patient support is an area of growing interest as consumers become more engaged in managing their care and as financial risk for benefits selections and care decisions shift to consumers.

Auditing. Auditing has emerged as an important functionality, since the Health Insurance Portability and Accountability Act (HIPAA) focused attention on monitoring and verifying how personal health information moves through and among health care systems. Auditing involves both the ability to track information and users, but also the ability to detect and prevent data theft.

Validation. Since physicians can come to rely on reminders or alerts generated by CPRs, data validation has grown in importance to eliminate actions resulting from erroneous data, which can have grave consequences. Validation can be organized into three separate components: a) data set conformance (are the data represented by reasonable definitions?); b) domain sensibility (do the data reflect what truly happened to the patient?); and c) completeness (are the data a full record of how the patient was treated?). The authors do not agree on whether validation is intrinsically necessary for CPR function, and, if so, what constitutes validation. In a cross-enterprise environment, validation would also include the comparison of disparate information about a single patient.

Among these authors, three perspectives were identified that were used to categorize CPR components. These perspectives are organized around:

Product Features. This approach characterizes CPRs based on what the product does. A prompt is a good example of a product feature. Tang and Hammond use this approach, as was common at the time of their article.

Technical Functions. This perspective describes how the product operates or what methods are used to accomplish the end result. For example, a prompt would be characterized according to how it functioned in a rules engine in this paradigm. Dick, Steen, and Detmer tend toward this perspective, although they have a somewhat mixed use of all three perspectives.

Business Processes. This approach characterizes CPRs according to the business processes that they impact or support, regardless of the underlying technology or features. For example, a prompt would be viewed as a physician behavior modifier under this perspective. While no author fully utilizes this paradigm, Waegemann comes the closest.

There has been progress made toward a business process-based classification of CPRs. While this is the most modern perspective for technology analysis, it is also the most complicated, since it ultimately depends on the end business result desired by the user. The Gartner Group published an example of a business process-based classification of CPRs. This classification identifies five separate generations of CPR systems based on the progressive results they yield. Such a classification system offers benefits in rigorously monitoring CPR adoption or in framing policy that influences adoption.

III. Use and Adoption of CPRs

Noting the wide variability in labeling and defining CPRs and the uncertainty this introduces into adoption research, the question turns to how widely CPRs are or will be used. Interviews with ambulatory surgery center leaders and the review of published literature suggest that CPR use within surgery centers is low. Only a few CPR products have been developed for these sites of care, and the usefulness of these technologies has been subject to debate. Some have argued that CPRs do not offer surgery centers the same return on investment as can be enjoyed by hospitals or ambulatory care sites, because patient visits to surgery centers are usually one-time events and do not represent an ongoing relationship. Because of the lack of published material in surgery centers, only CPR adoption in hospitals and physician offices was examined.

Unreliable Data

Even in hospitals and physician offices, where numerous studies have been reported, there are a number of factors that make current and planned CPR adoption rates unreliable. First, most of the published studies are industry-based, and have been descriptive in nature. Second, the compositional ambiguity of CPRs introduces error by allowing questions on surveys to be framed in a way that could bias responses. Third, few of these surveys assess the adoption of specific CPR functions or do not present this detail such that it is not possible to determine if findings have been over-generalized. Appendix 1 summarizes the design of reported CPR studies in comparative perspective.

Given the increasing attention to CPRs in public policy, the true rate of CPR adoption is important, and hence the quality of these studies warrants attention. Overall, most studies have lacked the controls and disclosures needed for generalization and critical review, respectively. Few of these studies report detailed methodology, nor do they characterize their sample size, predictive power, randomization, question validation or other essential elements of survey generalizability. Most of the studies are conducted by professional associations who appear to perform these studies on members or to satisfy member interests. Consequently, sample sizes are often small and the non-representative. For example, the 2002 Healthcare

Information and Management Systems Society (HIMSS) Hot Topics Survey and the Fourth Annual Medical Record Institute's (MRI) Survey were administered to attendees and exhibitors at these organizations' annual conferences and exhibitions. Besides being non-random, these attendees likely represent a more technologically inclined selection of respondents with higher technology adoption rates than non-participants. Similarly, surveys such as the 2001 Medical Group Management Association (MGMA) survey, which is administered solely to association members, are prone to biases inherent in the selection of organizational membership.

In addition to biases inherent in the survey population, self-selection biases can emerge among respondents, particularly when participant responses are unblinded and broadcast to the public. For example, the American Hospital Association (AHA) Most Wired Survey and the Leapfrog Group's IT assessment survey are both released to consumers and purchasers. Thus, respondents who believe their organizations are likely to receive recognition are more likely to respond than others, misrepresenting the actual national CPR use and adoption rate. In fact, hospitals participating in the AHA Most Wired survey were generally larger and more urban than the national average, both of which characteristics have been shown to be correlated with higher CPR use.

Other examples of poor study design were demonstrated. For example, many surveys such as the *Modern Physician*/PricewaterhouseCoopers Surveys, the 2002 HIMSS Hot Topics Survey, and the Annual HIMSS Leadership Survey before 2001, allowed multiple survey respondents per facility, permitting double counting and over-representation of large facilities. Also, surveys that are administered only online without traditional paper-based alternatives, such as the *Modern Physician*/PricewaterhouseCoopers Surveys, risk over-sampling respondents from more technologically able organizations, thus inflating technology adoption rates. Other aspects of study methods that raise concern include the surveys' mode of administration, their appropriateness of respondents, and whether the surveys are pre-tested. Finally, there is a large variety among study target populations. Some surveys sample only hospitals or ambulatory practices, while others sample both. Other surveys restrict their samples geographically or by specialty or by organization size.

Study design raises serious questions about the reliability of nearly every study we examined and whether conclusions can be drawn from these studies individually or as a whole. However, even though there are few well-designed industry surveys about CPRs, they are indeed the only information that can be compiled about the important phenomenon of CPR adoption. Hence, the findings of the reported studies are presented here with due caution.

Table 2. Current and Planned Inpatient CPR Adoption

Source	Inpatient CPR Use Current	Inpatient CPR Use Planned
Wall Street Journal, June 25, 2002	5%	--
HIMSS Survey 2002 (taken from 13th Annual HIMSS Leadership Survey)	13%	23%
HIMSS Survey 2001 (taken from 13th Annual HIMSS Leadership Survey)	13%	24%

Inpatient CPR Adoption

Inpatient CPR adoption has been reported in two studies performed by the industry association, HIMSS, and was also reported on by the *Wall Street Journal* this past year. These findings are summarized in Table 2.

The HIMSS studies show little change in actual or planned CPR use rates from 2001 to 2002, although study differences make interpretation of these surveys difficult. The *Wall Street Journal* reported a very low CPR use rate in 2002 but did not report its source. These reports suggest a low degree of interest in CPRs in inpatient settings, since more than 75 percent of respondents said they are not planning CPR implementation.

CPOE

One subset feature of inpatient CPRs that has gained significant media attention recently is computerized physician order entry (CPOE). There are several published forecasts of rates of planned adoption of the CPOE functions that are summarized in Table 3.

This table shows a large variation in estimates of current and planned use of CPOE. Leapfrog's estimates are quite low, as would be expected given the voluntary nature of their surveys, and industry champion HIMSS' estimates are quite high. With the exception of the survey results for HIMSS (larger) and Leapfrog (smaller), estimates of current CPOE use are similar to current overall CPR use rates at about 13 percent of facilities. Planned CPOE adoption rates reported by HIMSS markedly exceed those reported by other sources by a wide margin. Future CPOE adoption rates reported by HIMSS also exceed adoption rates for CPRs reported by all forecasters, including HIMSS.

The reason for these wide discrepancies is unknown, but such low inter-survey reliability reduces confidence in the use of these estimates for policy purposes. The gap in planned adoption rates between CPOE, a narrow subset of CPR functionality, and overall CPRs is most troubling. It is possible that interest in CPR-related technologies has grown in the 18 months between the surveys. Alternatively, health systems might be breaking off only one component of technology, the CPOE, and not pursuing the rest of the CPR, which would result in a major change in the organization of the products and offerings in the industry. A third explanation is that the ambiguity in what constitutes CPRs has led to a reporting bias in these subjective surveys. Finally, it is possible that health system leaders are simply stating gratuitous and inflated interest in CPOE because of the enormous market and policy pressure at this time. Resolution of this question is important in assessing the true state of CPR adoption in hospitals.

Table 3. Current and Planned Inpatient CPOE Adoption

Source	Inpatient CPOE Use Current	Inpatient CPOE Use Planned
HIMSS Hot Topics Survey, 2002	21%	67%
Leapfrog, 2001-2002	3.3%	30% next 2 yrs
Kaushal and Bates, 2001	13%	27%
Ringold, Santell and Schneider, 2000	13%	--
Ash, Gorman and Hersch, 1998	15% (17% partial)	--

Capability Gaps

The HIMSS survey reported a direct relationship between organization size and use of CPOE software. Most organizations with annual budgets of less than $100 million stated that they had no plans to implement CPOE software, while most organizations with annual budgets greater than $500 million stated that they were implementing CPOE software. Of note, private hospitals tended toward stating that they were in the discussion phase about CPRs, while most military or government hospitals reported that they were in the implementation phase.

Table 4 summarizes a recent AHA survey of hospital information technology utilization, which shows a large disparity in CPR use rates between hospitals considered to be 'most wired' and those that are considered to be 'less wired.' The capability gap between these cohorts is quite large, raising the question about how widespread CPR adoption is or will be. If these are valid findings and persist over time, a systematic differentiation among hospitals according to their information technology capabilities will emerge. Although this study did not analyze the characteristics of the cohorts according to patient demographics, network relationship and other factors, it is possible that these data are indicative of a broader technology gap (including patient care technologies, drugs, etc.) among hospitals.

As a side note, one other technology gaining broad adoption in hospitals is bar code technology. While this technology is not core to CPRs, it is a complementary technology and is an adjuvant in gaining the same business results sought by CPR investment. The HIMSS Survey showed that 77 percent of respondents said their organization uses bar coding technology, with laboratory (45 percent) and materials management (40 percent) being the two most prevalent foci of bar code use. Only 15 percent claimed their organizations use bar coding for medication administration management. As seen with CPRs, use of bar coding technology is a function of organization size. Organizations with operating budgets of less than $100 million were significantly behind organizations with larger annual budgets.

Table 4. CPR Use Rates in Most Versus Less Wired Hospitals

Feature	Most Wired Use Rate	Less Wired Use Rate
View lab results	82.0%	44.7%
Current medical records	81.0%	39.8%
Patient demographics	81.0%	45.1%
Medical history	78.0%	37.9%
Clinical decision support	63.0%	14.6%
Drug interaction alerts	59.0%	18.0%
Lab order entry	46.0%	12.6%
Pharmacy order entry	39.0%	7.8%

Source: Chin 2002; Solovy 2002

Table 5. Current and Planned Physician Office CPR Adoption

Source	Outpatient CPR Use Current	Outpatient CPR Use 1 Year	Outpatient CPR Use 2 Years
Modern Physician/PWC, 2002	39%	15%	28%
HIMSS/AstraZeneca, 2002	28%	--	--
MediNetwork, 2002	23%	31%	--
HarrisInteractive, 2002	17%	--	--
Loomis, Ries et al, 2002	14.4%	--	--
Modern Physician/PWC, 2001	27.3%	--	--
HarrisInteractive, 2001	22%	20%	--
MGMA, 2001	21.6%	33%	34.9%
Modern Physician/PWC, 2000	21%	--	--
Lippman, 2000	~5%	--	--
HarrisInteractive for BCG, 2000	17%	--	--
Modern Physician/PWC, 1999	11%	--	--
Modern Physician/PWC, 1998	2%	--	--

Physician Office CPR Adoption

CPR adoption in physician offices has been more widely surveyed than inpatient settings and displays more consistent findings. Table 5 summarizes 13 studies reported over the past four years on outpatient CPR adoption. Some of these also report projections for future use of ambulatory CPRs.

Current physician office CPR use rates reported in 2002 range from 14.4 percent to 39 percent of practices. The *Modern Physician*/Pricewatershouse Coopers study has been performed for the past four years with relatively consistent methods. This study shows an increase in outpatient CPR adoption growing from 2 percent in 1998 to 39 percent in 2002. Their 2002 study shows a 28 percent forecasted adoption for a total CPR penetration into physician offices of 67 percent two years from now. Consistent with this finding, the 2001 HarrisInteractive study projects a 56 percent rate of CPR adoption in one to two years.

These studies, taken together, suggest a relatively consistent use rate of 20 percent to 25 percent of practices using CPRs now and 50 percent to 60 percent in the near future. Taken at face value, if these studies are reliable and the results generalizable, this would mean that physician office CPRs have become a de facto reality and are diffusing more rapidly and becoming more widespread than inpatient CPRs.

As previously noted, the ambiguity in what functionalities constitute CPRs raises concerns over whether these studies are overgeneralizing the true rate of CPR adoption. To this end, a recent study by the MRI, shown in Table 6, details current and planned physician office CPR adoption by functionality.

This study demonstrates a great degree of variation in adoption of various functionalities, calling into question the aggregated CPR adoption data. For example, current use rates are as low as 2.8 percent for storage of voice or sound (a compo-

Table 6. CPR Adoption Rates by Functionality

	Function Use Current	Function Use 1 Year	Function Use 2 Years
Physician order entry	18.1%	22.4%	17.8%
Results reporting	32.1%	8.1%	5.2%
Storage of reimbursement codes (ICD, CPT), data, text	21.6%	9.8%	6.3%
Storage of voice or sound	2.8%	3.2%	3.2%
Storage of clinical images	9.9%	7.8%	7.0%
Medical record document imaging systems	13.3%	9.9%	5.5%
Passwords	90.4%	2.9%	0.7%
Electronic signatures	62.2%	34.2%	15.6%
Backup and recovery	82.7%	2.5%	0.2%
Virus detection	87.5%	2.0%	0.5%
Data encryption	53.6%	8.9%	3.8%

Source: MRI 2002

nent of recording information) and as high as 90.4 percent for passwords (a component of security and authentication). While these rates are quite disparate, they represent both ends of the technology adoption curve rather than a metric for where CPRs currently stand. One of the most basic components of CPRs is results reporting, such that it could be considered an index of CPR adoption. The current use rate of results reporting is 32 percent, on par with estimates of general CPR adoption. These data suggest that despite having a CPR, physician offices phase in functionality over time rather than adding new capabilities at the same time.

Comparisons Abroad

Available data on CPR adoption rates by physician specialty were examined. As shown in Table 7, CPR use rates in physician's offices varies with physician specialty. The HIMSS study shows that 8 percent of pediatric practices state that they use CPRs, while 42 percent of internal medicine practices do. According to this survey, multi-specialty practices, primary care physicians (e.g., family practice physicians), and specialty practices all state a CPR use rate of 27 percent to 30 percent. It is not clear why these variations in adoption rates exist, or whether they result from sampling biases or errors in classifying

Table 7. Physician Office CPR Adoption by Specialty

Specialty	Outpatient CPR Use Rate
Internal Medicine Practices	42%
Multi-specialty Practices	33%
Family Practices	30%
Specialty Practices	27%
Pediatric Practices	8%

Source: HIMSS 2002

types of practice environments. If they are reproducible, further examination would yield important insights into how CPR adoption is influenced by variations in practice styles, group size, reimbursement economics, and other factors.

Two surveys from Harris Interactive place the United States within an international context, as shown in Table 8. These surveys demonstrate that the United States lags far behind other countries, with the exception of Portugal, France, Spain, and Canada, in CPR adoption by primary care physician offices. Indeed, the United States is tied (with Greece) for fifth from the last among North America and Europe in CPR use (Chin 2002). Adoption of CPRs by 12 percent of specialists in the United States is similar to other surveyed countries, with the exception of the United Kingdom where 22 percent of specialists reported CPR use.

The most commonly cited reason why the United States lags behind other countries in CPR adoption is that health care in the United States is more fragmented with its multi-payer, non-centralized system. If this is the case, then the question arises about how CPRs will gain widespread adoption in the face of this fragmentation. Adoption of interoperability standards has been raised as a means of fostering CPR adoption.

Table 8. International CPR Adoption Rates

	Primary Care Phys. Use, 2002	Primary Care . Phys. Use 2000	Specialist Use, 2000
Canada	-	14%	16%
Australia	-	25%	13%
New Zealand	-	52%	14%
Portugal	5%	-	-
France	6%	-	-
Spain	9%	-	-
United States	17%	17%	12%
Greece	17%	-	-
Ireland	28%	-	-
Luxembourg	30%	-	-
Italy	37%	-	-
Belgium	42%	-	-
Germany	48%	-	-
Austria	55%	-	-
Finland	56%	-	-
United Kingdom	58%	59%	22%
Denmark	62%	-	-
Netherlands	88%	-	-
Sweden	90%	-	-

Source: Harris Interactive 2001, 2002

IV. Factors Influencing CPR Adoption

There has been a great deal written about the drivers of—and barriers to—adoption of CPRs. CPR drivers are numerous and are best summarized by a recent study by the MRI. The factors that increase adoption fall into two categories, administrative and clinical. Major administrative drivers of CPR adoption are:

- Need to share comparable patient data among different sites within a multi-entity health care delivery system (75.7 percent)
- Need to improve clinical documentation to support appropriate billing service levels (75.3 percent)
- Requirement to contain or reduce health care delivery costs (66.3 percent)
- Need to establish a more efficient and effective information infrastructure as a competitive advantage (64.3 percent)
- Need to meet the requirements of legal, regulatory, or accreditation standards (60.4 percent)
- Need to manage capitation contracts (21.8 percent)

Major clinical factors driving CPR adoption are:

- Improve ability to share patient record information among health care practitioners and professionals within the enterprise (90 percent)
- Improve quality of care (85.3 percent)
- Improve clinical processes or workflow efficiency (83.8 percent)
- Improve clinical data capture (82.6 percent)
- Reduce medical errors (patient safety) (81.9 percent)
- Provide access to patient records at remote locations (70.9 percent)
- Facilitate clinical decision support (70.4 percent)
- Improve employee/physician satisfaction (62.8 percent)
- Improve patient satisfaction (60.2 percent)
- Improve efficiency via pre-visit health assessments and post-visit patient education (39.9 percent)
- Support and integrate patient health care information from Web-based personal health records (30.3 percent)
- Retain health plan membership (9.5 percent)

These drivers represent chronically persistent needs for hospitals and physicians, who have remained remarkably resilient in pursuing the benefits of CPRs despite significant obstacles beyond the control of the typical hospital or physician. Two such obstacles are location and organizational size.

Urban Areas Quicker

The rate of adoption of CPRs appears to be related to the degree of urbanization of the physician practice market, as depicted in Table 9. This table shows that CPR adoption in major urban markets is 1.5 times greater than in small non-urban markets.

Organizational size also appears to influence CPR adoption in both inpatient and ambulatory settings, as shown in Table 10. This table shows that large hospitals have electronic capture of 30 percent more patient information than small hospitals have. This difference persists across both inpatient and ambulatory services of the hospital.

While urban areas may not, in themselves, be catalysts for CPR adoption, there is a spatial correlation between urban areas and large health care provider organizations. Large organizations have a decided advantage in all aspects of the information technology implementation lifecycle, including planning, financing, acquiring, installing, implementing, and supporting these systems. Most smaller organizations simply do not have the resources to invest in, implement, or operate the complicated infrastructure that make up modern CPRs.

Major Barriers Exist

To better understand the barriers to CPR adoption, Table 11 summarizes the findings of three major studies conducted over the past three years. These studies cover both inpatient and physician office settings. While each study categorizes barriers differently, some correspondence exists in their approaches. In the Table 11 the MRI study is used as the index.

Table 9. Electronic Data Capture by Regional Population

	Total	Non-metropolitan		Metropolitan		
		< 25K	25 - 49.9K	< 250K	250-1 million	> 1 million
Mean	38.0%	29.6%	35.8%	35.4%	39.9%	41.7%
Median	25.0%	10.5%	21.0%	25.0%	30.0%	30.0%

Source: Lorence, Spink et al. 2002

Table 10. Electronic Data Capture by Organization Size

	Hospital Inpatient Visits				Hospital Outpatient Visits			
	1-10.5K	10.501 -30K	30.1 -98K	> 98K	1-10.5K	10.501 -30K	30.1 -98K	> 98K
Mean	33.4%	38.1%	40.0%	41.2%	32.6%	37.7%	38.3%	40.9%
Median	20.0%	25.0%	30.0%	30.0%	20.0%	25.0%	30.0%	30.0%

Source: Lorence, Spink et al. 2002

Table 11. Barriers to CPR Adoption

Barrier to CPR Adoption	MRI, 2002	MGMA, 2001			HIMSS		
		Combine	<10 MDs	10-49 MDs	>50 MDs	2001	2002
Lack of funding or resources	58.5%	48.1%	48.4%	46.9%	49.4%	21%	27%
Lack of support by medical staff	35.4%	29.7%	26.4%	30.6%	41.4%	11%	16%
Achieving end-user acceptance	--	--	--	--	--	11%	16%
Skills and preferences of existing support staff	--	25.3%	43.8%	19.4%	20.7%	11%	16%
Inability to find CPR at affordable cost	31.7%	--	--	--	--	--	--
Difficulty migrating from paper to electronic	31.2%	30.0%	28.7% .	32.5%	31.0%	14%	8%
Time and effort to prepare organization for CPR	31.2%	42.5%	43.8%	42.5%	37.9%	14%	8%
Difficulty integrating systems	31.2%	30.0%	28.7%	32.5%	31.0%	14%	8%
Difficulty finding satisfactory CPRsolution not fragmented over several vendors	28.7%	--	--	--	--	--	--
Inadequate/incomplete health care information standards (data, connectivity, etc.)	25.2%	9.9%	7.8%	11.9%	13.8%	--	--
Difficulty evaluating/comparing/ validating capabilities of CPRs in marketplace	24.9%	--	--	--	--	--	--
Unable to find CPR that meets requirements	22.9%	6.2%	5.8%	5.6%	9.2%	14%	17%
Difficulty building a strong business case for a CPR	20.1%	29.7%	26.1%	33.1%	37.9%	15%	13%
Lack of structured medical terminologies	12.4%	--	--	--	--	--	--
Lack of easy way to input data and notes	--	17.9%	17.1%	17.5%	21.8%	--	--
Security concerns	--	11.0%	13.3%	5.0%	5.7%	--	--
Lack of management support	--	9.8%	7.0%	7.5%	1.1%	6%	8%
Recruiting and retaining high quality staff	--	--	--	--	--	6%	4%

Source: MGMA 2001; HIMSS 2002; MRI 2002

Financing Top Barrier

All three studies show funding and resource availability as the largest barrier to CPR adoption, regardless of hospital or physician office and size. This is validated by a recent Sheldon Dorenfest study (2002), which showed that 44 percent of hospitals spent less than 2 percent of their budgets on information technology and 93 percent spent less than 4 percent of their budgets on information technology. Only 7 percent of hospitals spent 4 percent or more of their budgets on information technology, which has been described by some as a threshold for rapid information technology adoption in hospitals. Likewise, physicians, both CPR users and nonusers, stated that they believe that current CPRs are too costly. This supports the previously published view that physicians believe current CPRs are not cost effective.

The financial barrier to CPR adoption is well documented. On the 2002 MRI survey, lack of adequate funding and resources outranked all other barriers with 58.5 percent of respondents citing it. Similarly, on the 2002 MGMA survey, lack of resources emerged as the top barrier with 48.1 percent of respondents selecting it. Lack of resources was also the top barrier among various sub-groupings of physician practices based on number of full-time equivalent (FTE) physicians. It was cited by 48.4 percent of practices with fewer than 10 FTE physicians, 46.9 percent of practices with 10 to 49 FTE physicians, and 49.4 percent of practices with 50 or more FTE physicians. On the 13th Annual HIMSS Leadership Survey, lack of funding was again the top barrier to CPR adoption with 27 percent of respondents citing it.

While some studies have shown that CPRs reduce medical errors and reduce medical costs, the cost savings most frequently cited are administrative–time, paper, staffing, etc. Regardless of whether savings are clinical or administrative, nearly all authors agree that CPRs can reduce cost or reduce the rate of cost growth. Financial barriers remain an obstacle, however, because cost savings are realized in the medium- to long-term while CPR acquisition requires large up-front investment. Additionally, most institutions that adopt CPR systems still maintain paper records so that administrative cost savings are not realized. Ironically, the cost of complexity and redundancy is introduced by CPRs rather than eliminated.

CPRs are regarded as unduly expensive items and usually entail a large flat fee plus licensing fees per user. A study conducted by Loomis et al of members of the Indiana Academy of Family Physicians found that CPR users and nonusers alike believe that current CPRs are too costly. A total of 87 percent of the family physicians in this study indicated that they would be willing to pay a relatively low set-up fee of less than $5,000, and 81 percent of respondents indicated that they would be amenable to a low monthly fee of less than $100. Few CPRs, however, can be implemented within these price restrictions. According to one study, a typical office-based client-server CPR can cost from $20,000 to $50,000 per physician in the first year while a top-of-the-line model can cost up to $70,000 per physician. Web-based CPR applications offer a cheaper alternative to client-server models with monthly service fees ranging from $200 to $600 per physician. Despite these cheaper alternatives, hidden costs can exist with implementing these systems. Integrating a CPR system with a practice's existing labs, radiology, and billing systems can introduce additional costs up to $15,000 in the first year. A recent report conducted by Partners HealthCare Systems' Center for Information Technology Leadership suggests that published CPOE cost estimates may even be too conservative. This report advises that practices should expect to spend up to $29,000 per doctor to install and up to $12,000 a year to maintain top-end ambulatory CPOE systems. Cheaper systems can be obtained at around $4,500 per physician, but their payback period is longer than the two-year estimate of the top-end systems.

Given the high cost of acquiring and implementing CPRs, most institutions that acquire these systems are those that can employ economies of scale. These institutions are able to spread the large initial cost of acquiring these systems over larger medical and support staffs, thus reducing their average cost per user. These institutions also tend to be those with higher annual revenues as shown by the HIMSS/AstraZeneca Clinician Wireless Survey, which found a positive correlation between annual revenue and CPR use. Only 20 percent of facilities with CPRs in this study had annual revenues of less than $1 million, while 36 percent had revenues between $5 million and $10 million, and 28 percent had revenues in excess of $10 million.

Despite their high cost, CPRs continue to be the most frequently cited software purchases among ambulatory practices with 38 percent of practices purchasing them, according to the 2002 HIMSS/AstraZeneca Clinician Wireless Survey. Health care industry leaders have suggested that CPR adoption should be encouraged through incentives in which payers including the government share the cost of implementing and maintaining CPR and CPOE systems. Proponents of these plans argue that payers benefit from reduced medical errors, quality of care improvements, and emergency preparedness generated by these technologies. They point to Australia, New Zealand, and the United Kingdom, which have successfully introduced government funded programs for stimulating adoption and use of CPRs. Bates et al. reports that in Australia, 70 percent of general practitioners said that the majority of the physicians in their practice used a CPOE in 2000 compared with only 15 percent who said that they were using a computer for any purpose in 1997.

The American Academy of Family Physicians (AAFP) has developed another solution to the prohibitive cost of CPRs. The AAFP is planning to create a nonprofit foundation to develop and sell a low-cost "open-source" CPR software with no licensing fees. Unlike proprietary software, the source code for this open-source software would be freely shared over the Internet as long as any modifications to the code were also shared over the Internet. The software would thus encourage open standards and compatibility with other technologies. Unresolved issues for the planned software include its provided level of technical support and its medical support tools.

Physician Resistance

CPR adoption studies consistently report medical staff resistance as the second largest barrier after cost. These concerns should subside in the long run, as suggested by a recent study of medical school graduates of whom 75 percent felt well-prepared to use a computer-based clinical records system as compared with only 31 percent in 1998. However, Loomis reported that there appear to be no differences in physician CPR use by age (or by gender), which suggests that only now is the "computer generation" of physicians beginning to enter practice.

In the near term, however, physician resistance is a substantial barrier. In extreme cases, physician resistance has manifested itself in boycotts of CPRs or threats of strikes by physicians and nursing staffs in response to implementation of CPOE systems. More commonly, however, physician resistance assumes a more passive form with physicians simply avoiding these technologies. In settings where physicians are not required to use these technologies, they accordingly choose not to use them. Ash et al. found that more than half of hospitals with CPOE installed reported that only 10 percent or less of their medical staffs actually use the system. Only 11.7 percent of hospitals with CPOE available reported that more than 90 percent of the medical staff use the system. Not surprisingly, among these hospitals with CPOE available, only 13.7 percent require its use while 23.7 percent encourage it. For the remaining 62.6 percent of hospitals, CPOE use is optional. With regard to saturation of CPOE, Ash et al. found that 57.7 percent of

hospitals with CPOE installed reported that only 10 percent or less of orders are entered on the system. Only 9.0 percent of hospitals with CPOE available reported that over 90 percent of orders are entered on the system. Although a similar study has not been conducted for CPRs, the high rate of dual maintenance of paper and electronic patient records suggests that the number of physicians using CPRs at institutions where they are available may also be low.

The factors cited in the literature for physician resistance to CPRs and CPOEs are numerous. They include computer anxiety, increased time to enter orders and patient histories compared with previous paper-based methods, decreased patient-physician interaction, inability of the applications to integrate into physicians' workflow, and decreased educational opportunities.

Among the factors listed above, computer anxiety is one of the more easily overcome. Increasingly, physicians are using computers and using the internet and email in their personal and professional lives. Studies have furthermore shown that initial computer anxiety among less experienced users can be overcome with experience, leading to greater satisfaction with CPR use. Nevertheless, for hospitals and practices seeking to adopt CPRs and CPOEs, computer anxiety and lack of computer experience among medical staffs can adversely affect staff support of these systems.

Time Barriers

Increased time to enter orders and patient histories with CPRs and CPOEs is a frequent complaint among physicians; however, studies quantifying the time these systems require have produced varied results. In a study comparing CPR use among academic-based physicians and community-based physicians, Penrod and Gadd found that while the academic-based physicians rated CPR use as detrimentally affecting time for documentation and order entry, the community-based physicians found it beneficially affected time for documentation. The community-based physicians were neutral to its affect on time for order entry. In the case of CPOE, Bates et al found that physicians could spend twice as much time using CPOE than other ordering methods in inpatient settings. Similarly, Massaro determined that inpatient CPOEs could consume up to four additional hours of physicians' time per day, although less than 10 percent of physicians spent more than on hour on order entry each day. A more recent study, however, of primary care internal medicine practices revealed that physicians using CPOE spent 2.2 minutes more per patient overall, but when duplicative administrative activities were accounted for, this number fell to 0.43 minutes. Overhage et al further determined that with experience, physicians' order entry time fell by 3.73 minutes, demonstrating that with experience, CPOEs can save physicians time. Despite this hopeful result, it is clear that at the outset, physicians will require extra time for order entry on these systems, which can represent a burden on their already busy schedules.

Decreased physician-patient rapport induced by CRP and CPOE use has been a major criticism of adoption of these technologies. Physicians have argued that entering data and notes into CPRs and CPOEs requires undivided attention, taking time away from patient care. In Penrod and Gadd's 2001 study of inpatient physicians, they found that both academic-based physicians and community-based physicians rated CPRs as detrimental to patient rapport. In another study conducted in outpatient settings, however, these authors found that while physicians grew increasingly concerned about loss of physician-patient rapport with CPR use, their patients did not indicate any sense of lost rapport with their physicians when CPRs were used during their visits.

Poor integration into physicians' workflow represents another significant and chronic physician complaint against CPRs and CPOEs. Although these complaints are often specific to the applica-

tions being used, they generally argue that these applications are overly complicated with too many screens, their input mechanisms are inflexible and time-consuming, complex information cannot be easily expressed, and they lack adequate space for notes. The importance of screen design and layout of these systems is underscored by the Sittig et al finding that user satisfaction is most highly correlated with screen design and not system response time. In addition to the workflow issues mentioned above, implementation of CPRs and CPOEs can create changes in responsibilities, patterns, and priorities of work among medical staff members, resulting in greater burdens being placed on certain individuals. Gradual implementation of these systems with significant clinician involvement and support during and after this process is therefore recommended to avoid introducing medical errors and inefficiencies with the adoption of these technologies.

Teaching Barrier

Decreased opportunity for education is a drawback of CPOE systems, according to a study by Ash et. al. In academic hospitals, interns have traditionally entered orders for attending physicians. CPOEs have diminished the educational value of this activity by introducing "cookbook medicine" that doesn't require interns to think orders through and carefully consider the patient's medical history. Similarly, physician supervisors who were previously able to assign medical students the task of writing orders for review felt the loss of this educational exercise with the implementation of CPOE.

Another key barrier to CPR adoption was the form of data entry. A recent study of data entry method use rates by physicians is shown in Table 12.

This study shows that computer-based text entry is now on par with dictation, but more structured means of inputting data, which are necessary for interoperability, lag far behind.

Overall, the barriers to CPR adoption are large, and even though progress is being made, the barriers of cost and physician resistance are substantial and enduring. In many ways the physician resistance and cost barriers are interdependent. The policy challenge in many ways is not to make the benefits of CPRs more compelling, but to make the barriers less challenging.

Table 12. Use Rates of Clinical Data Entry Methods

Clinical Data Entry Method	Current Use Rate
Direct input using keyboard or mouse	72.8%
Dictation/transcription	68.6%
Structured data entry using a keyboard/mouse (using templates or fields or XML DTDs)	49.9%
Document scanning	42.0%
Input from other departmental or CPR systems	41.8%
Structured data entry via a touch screen	15.8%
Speech recognition	12.0%
Structured data entry using a light pen	5.3%
Other data capture methods	7.3%

Source: MRI 2002

V. Use and Adoption of Standards

STANDARDS ADOPTION POSES A DIFFICULT challenge for the health care industry. Difficulties in moving data seamlessly between systems, which is the ultimate result of a lack of standards among CPRs, lies at the core of many of the quality, efficiency, and access problems experienced in health care today. However, despite much work on the content of interoperability standards, little has been written about the current state of their use or about the barriers to their adoption.

To the typical health care executive or physician, standards are an abstract and irrelevant topic. For example, lack of health care information standards was cited as a barrier to CPR adoption by only 25 percent of hospitals and a smaller share of physician groups. Some organizations, such as the Veterans Health Administration, have given substantial attention to interoperability across health systems. However, this is unusual, even within health care enterprises, where CPR interoperability has a real impact on whether the CPR is cost-effective, useable, and clinically beneficial.

What is known about the adoption of standards is limited. According to a 1998 study of 162 CIOs, HL7 was the most widely used standard among health care providers. More than 80 percent of respondents claimed to use HL7 standards, and 13.5 percent claimed they planned to implement the HL7 standards. Nearly all large hospitals (400 beds or greater) claimed HL7 use. Likewise, a 1997 HIMSS/Hewlett-Packard study identified HL7 as the dominant standard in the healthcare arena, with two-thirds of respondents identifying HL7 as the most important standard for their organizations. In this study, DICOM and SGML/HTML were tied for second behind HL7, with 21 percent of respondents rating them as most important, followed by X12, which received a 19 percent rating of importance.

The MRI survey provides some insight into standards adoption, as shown in Table 13.

Table 13. Use and Rate of Adoption of Standards

	Standard Use Current	Standard Use 1 Year	Standard Use 2 Years
Audit logs	60.9%	9.5%	2.4%
Digital certificates	32.9%	10.0%	10.5%
Biometric technologies	32.0%	2.4%	10.2%
Master patient index for single system or site of care	22.7%	4.6%	1.5%
Integration engine to connect the data repository to clinical workstations & departmental systems	22.2%	6.0%	2.0%
Network connecting data repository to clinical workstations and departmental systems	20.9%	7.0%	3.3%
Storage of clinical codes (LOINC, MEDCIN, SNOMED)	10.9%	7.4%	4.6%
Master person index or enterprise directory to support multiple facilities	9.8%	2.8%	2.0%

Source: MRI 2002

This study identifies low adoption rates for some of the standards that are critical to interoperability. For example, only 30 percent of respondents state that they will implement unique patient identifiers and interconnectivity over the next two years, and 20 percent will implement standardized clinical terminology (codes). Approximately 70 percent claim that they will implement audit logs in two years, although this may be an artifact of the psychology surrounding HIPAA concerns when this study was performed. Overall, this study demonstrates the weak imperative for adoption standards and difficult barriers faced by efforts to drive widespread adoption of interoperability standards.

Except for these findings, no data were identified regarding planned adoption of information standards. This stands in marked contrast to the extensive publication pool on this topic that is overwhelmingly focused on the standards themselves and not about the drivers and adoption factors. This deficit of knowledge is a critical absence in the dialogue about interoperability and the national effort to stimulate CPR adoption.

VI. Observations and Discussion

Despite the confusion in real data, it appears that the use of CPRs is growing and is likely to grow in the future. Despite remarkable barriers to adoption, there are significant technical, economic, legal, professional, and cultural reasons for this growth. While few of these secular trends toward automating the flow of information in health care organizations and computerizing the physician workplace can be influenced by public policy, they will inevitably result in adoption of some form of CPR. However, the issue at stake is not whether CPR use is growing, but whether the adoption of this technology will improve the health status of Americans. This issue relies upon three questions:

- Whether CPR adoption is growing at a sufficiently fast pace;
- Whether adoption disparities will create two tiers of care; and
- Whether CPRs will be interoperable or stand-alone.

Reliable Data

First and foremost, policy considerations need to recognize that very little is known about the true rate of adoption of CPRs and interoperability standards. It is still a question as to whether surgery centers or other ancillary care providers are adopting these tools, and, if they are, how they use them. The true adoption rate of CPRs by hospitals is not known, since information comes from episodic, poorly designed and incomparable, cross-sectional descriptive surveys. What is known has largely been collected by industry proponents, and the gap between these studies and others suggests that these studies overstate the true rate of adoption.

Public policy would benefit from an objective and rigorous longitudinal survey of CPR and interoperability standards adoption that covers all relevant sites of care and which can be relied upon to monitor the true rate of adoption of these tools. These data should focus on the business-process use of CPRs and their reliability over time and comparability across proprietary products. Such a survey should give attention to the modern view of CPR functionality, including patient identification, patient support, and data validation, which are important given the increasing dependency of physicians on CPRs and the ongoing evolution of information technology in the industry.

Eliminating Barriers

Of the various ways to accelerate adoption of CPRs, the most promising is eliminating or bypassing major barriers, particularly the business case and physician resistance. These two largest barriers to CPR adoption are interdependent and are expressions of the underlying schism between physicians and hospitals. Given the arms-length and often conflicted relationship between hospitals and physicians, policy should assume that hospitals and physician groups are being economically rational in their CPR adoption decisions for the following reasons. From a financial perspective, the only certainty in CPR adoption for the hospital or physician group is the payout to the vendor or to the organization's information technology staff. What is not known by any specific organization is whether they will get financial returns and, if so, when. These organizations appear to be dismissing or discounting the generic value proposition that is often and loudly claimed by CPR proponents. This is not unlike a risk premium for these organizations that reflects uncertainty about whether physicians will use the tools and to what degree behaviors and processes will change.

Physicians, on the other hand, would prefer not to implement CPRs. Even if they do overcome their reluctance, they may not be aware of the degree of support they need to make beneficial use of a CPR. Hence, many may try to use CPRs and fail, fulfilling their prior negative bias. Unless substantial support is given, physicians will not be able to configure their systems, train for their use, integrate them into their workflow, and support the transition of their staff. In other words, if left alone, most physicians will fail at CPR implementation. The only organizations that can help them are hospitals and large physician groups, and it is clear from surveys that the larger the organization, the more capable it is with CPRs. However, there are real constraints, some of them federal, on a hospital's ability to support physician adoption of CPRs.

Consequently, in implementing CPRs, hospitals face a large and risky investment and have limitations on the actions they need to take to generate returns.

In short, the realities of health care delivery justify the risk premiums discounted from benefits that hospital managers (implicitly) determine, which justifies their decisions to delay CPR adoption. Ironically, the remedy to the largest barrier to CPR adoption, financial resources, may lie in reducing the second barrier, physician resistance. Policymakers must consider how to enable CPR buyers—be they hospitals or physician groups—to take actions that support physician adoption of CPRs, which in turn will make the financial case for CPR adoption stronger. Additional funding or financial incentives may help some organizations adopt CPRs, but this will not help other organizations that do not have the managerial, technical, or clinical capacity to adopt CPRs successfully.

Two-tiered System

Regardless of the overall rate of CPR adoption, there are separate concerns about the growing CPR adoption gap between large, urban organizations and their smaller, non-urban counterparts. If the value proposition of CPRs is to be believed, and the data on adoption by type of organization are reliable, then the United States is at or very near a two-tiered system of care based solely on CPR capabilities. The data presented in this paper suggest that the CPR adoption gap is already quite prominent, although more objective data could verify or refute this. This is a difficult challenge to address because small organizations have many interrelated barriers to CPR adoption that are intrinsic attributes of their small size (e.g., short planning horizons, limited staff depth, limited expertise, high cost of capital, etc.). This complex problem means that CPR loan funds or other means of subsidizing these organizations will result in a higher rate of CPR uptake by them, but possibly a commensurately

higher rate of CPR implementation failure. This is a situation where regional or sectoral CPR support organizations that can assist in all aspects of CPR adoption for small and rural hospitals or physician groups could be useful. Good examples of this are regional consortia of community health centers, which have "outsourced" back office and information technology operations from small, low (or negative) margin "storefronts." Given the current state of CPR adoption, urgent attention to preventing a CPR adoption gap is recommended.

Standards Could Be the Key

There appears to be little cause for optimism that the market will drive adoption of standards. According to the data, standards adoption faces substantial obstacles in physician disinterest, vendor resistance to a potential loss of service revenue, and a first-mover disadvantage that arises from the need for two different systems to be standards-compliant in order to be beneficial. The interoperability market failure results from every entity bearing a small cost for not being interoperable while the aggregate consumer welfare loss from non-interoperability is arguably quite large.

The traditional framework for approaching CPRs is that enterprise self-interest will drive CPR adoption, and that having the technology in place will reduce physician resistance, which will, in turn, drive standards, interoperability, and cross-enterprise integration. It is possible, however, that many organizations will simply conclude that it is not in their interest to implement CPRs because of entrenched physician resistance and other refractory barriers. If this is the case, policy efforts to shift enterprise decisions toward CPR adoption will achieve only marginal, if any, success.

A contrarian framework suggests that interoperability is the key to CPR adoption and not vice versa. This view is based on the assumption that interoperability can reduce physician resistance to CPRs. While CPRs make it easier for physicians to get information and to interact with it, CPRs do not, in themselves, reveal new facts to the physician. Standards-enabled CPRs can transform the physician experience, since they can seek and present facts about a patient that a physician may have never known. Hence, the adoption of standards could make CPRs more beneficial to physicians, which will in turn reduce physician resistance to CPR, which will in turn make the CPR investment less risky to the hospital or physician group. Each standards-based CPR will benefit other CPR users, and so on, creating a positive network externality.

Policy attention should be given to the question of whether accelerating standards adoption can be a catalyst to overall CPR adoption. This means shifting attention away from "supply" of standards (agreeing to and disseminating the content of standards, for example), and shifting attention to "demand" for standards. The substantial research and policy attention focused on the content of standards assumes a demand for standards not documented here. Attention should be given to both the content of standards and also to the demand for standards, which means making a clear case for how interoperability changes the daily work of physicians, patients and others in health care in a positive manner. As learned through the diffusion of the Internet, the widespread adoption of standards and interoperability may not only drive CPR adoption but will transform the very notion of the CPR.

Bibliography

1st Medical Informatics Master Class, Rolduc Kerkrade, Netherlands. "Minutes from the 1st Medical Information Class in Rolduc Kerkrade," 1999.

Alschuler, L. Presentation: HL7, 2001.

Andrew, W. F. "CPR Systems Review 1998-2002." *Advance for Health Information Executives.*

Appavu, S. I. Analysis of Unique Patient Identifier Options Final Report, Department of Health and Human Services, 1997.

Ash, J. S., P. Gorman, et al. "Physician Order Entry in U.S. Hospitals." *Proceedings of the AMIA Annual Symposium:* 235-239, 1997.

Ash, J. S., P. N. Gorman, et al. "Perceptions of house officers who use physician order entry." *Proc AMIA Symp:* 471-5, 1999.

Ash, J. S., P. N. Gorman, et al. "A Cross-site Qualitative Study of Physician Order Entry." *J Am Med Inform Assoc* 10(2): 188-200, 2003.

Ball, M. J., D. E. Garets, et al. Leveraging IT to Improve Patient Safety. *International Medical Association Yearbook 2003.* New York: F.K. Schattauer Publishing Co., 2003.

Association of American Medical Colleges. AAMC 1998 Medical School Graduation Questionnaire - All Schools Report, 1998.

Association of American Medical Colleges. AAMC 1999 Medical School Graduation Questionnaire - All Schools Report, 1999.

Bates, D. W., D. L. Boyle, et al. "Impact of computerized physician order entry on physician time." *Proc Annu Symp Comput Appl Med Care:* 996, 1994.

Bates, D. W., M. Ebell, et al. "A proposal for electronic medical records in U.S. primary care." *J Am Med Inform Assoc* 10(1): 1-10, 2003.

Blair, J. S. An Overview of Healthcare Information Standards. Computer-based Patient Record Institute.

Blum, E. "Paperless medical record not all it's cracked up to be." *American Medical News,* 2003.

Brewin, B. "Several Factors Slowing Adoption of Key Health Care IT Systems." *Computer World,* 2002.

Chin, H. L. and M. A. Krall. "Successful implementation of a comprehensive computer-based patient record system in Kaiser Permanente Northwest: strategy and experience." *Eff Clin Pract* 1(2): 51-60, 1998.

Chin, T. "Electronic medical records: Mastering the maze." *American Medical News,* 2001.

Chin, T. "Americans trail much of Europe in adopting electronic medical records." *American Medical News,* 2002.

Chin, T. "Hospitals are becoming more wired, AHA survey reports." *American Medical News,* 2002.

Chin, T. "Hospitals eye order entry." *American Medical News,* 2002.

Chin, T. "AAFP seeking support for low-cost EMR." *American Medical News,* 2003.

College of Healthcare Information Management Executives and HCIA, Inc. H.I.S. Desk Reference: A CIO Survey, 1998.

"Computers and Family Practice." *FP Report,* 1996.

Conn, J. "Study: Ambulatory CPOE costs can be recouped in short order." *Modern Physician,* 2003.

Dansky, K. H., L. D. Gamm, et al. "Electronic medical records: are physicians ready?" *J Healthc Manag* 44(6): 440-54; discussion 454-5, 1999.

DeJesus, E. "Claims Processing Speeds Up." *Healthcare Informatics* 17(6), 2000.

Dick, R. S., E. B. Steen, et al., Eds. *The Computer-based Patient Record: An Essential Technology for Health Care.* Washington, D.C.: National Academy Press, 1997.

Doolan, D. F. and D. W. Bates. "Computerized physician order entry systems in hospitals: mandates and incentives." *Health Affairs* (Millwood) 21(4): 180-8, 2002.

Dorenfest, S. Personal communication. D. J. Brailer, 2002.

"Electronic Medical Record Usage Expected to Skyrocket." *Advance for Health Information Executives,* 2001.

"European Physicians Especially in Sweden, Netherlands, and Denmark, Lead U.S. in Use of Electronic Medical Records." *Harris Interactive Health Care News* 2(16), 2002.

Gadd, C. S. and L. E. Penrod. "Dichotomy between physicians' and patients' attitudes regarding EMR use during outpatient encounters." *Proc AMIA Symp:* 275-9, 2000.

Gamm, L. D., C. K. Barsukiewicz, et al. "Pre- and post-control model research on end-users' satisfaction with an electronic medical record: preliminary results." *Proc AMIA,* 1998.

Hammond, W. E. "The status of healthcare standards in the United States." *Int J Biomed Comput* 39(1): 87-92, 1995.

Hammond, W. E. "Call for a standard clinical vocabulary." *J Am Med Inform Assoc* 4(3): 254-5, 1997.

Hammond, W. E. Presentation: Patient Safety Data Standards: View from a Standards Perspective, 2002.

Hammond, W. E. and M. McDougall. "Health Level Seven: the clinical data interchange standard." *J AHIMA* 67(8): 42-5, 1996.

Hammond, W. E., W. W. Stead, et al. "Functional characteristics of a computerized medical record." *Methods Inf Med* 19(3): 157-62, 1980.

Herpok, F. J., J. P. Hansen, et al. "Total medical record: an automated medical information system." *Med Group Manage* 26(5): 37-40, 46. Symp: 225-9, 1979.

HIMSS/AstraZeneca. HIMSS/AstraZeneca Clinician Wireless Survey, 2002.

HIMSS. 13th Annual HIMSS Leadership Survey, HIMSS, 2002.

HIMSS. HIMSS 2002 Hot Topics Survey. Atlanta, Annual HIMSS Conference and Exhibition, 2002.

HIMSS/Hewlett-Packard. 1997 HIMSS/Hewlett-Packard Leadership Survey, 1997.

Hodge, R. "Myths and realities of electronic medical records. 9 vital functions combine to create comprehensive EMR." *Physician Exec* 28(1): 14-20, 2002.

Kaushal, R. and D. W. Bates. Chapter 6: Computerized Physician Order Entry (CPOE) with Clinical Decision Support. *Making Health Care Safer - A Critical Analysis of Patient Safety Practices,* Agency for Healthcare Research and Quality, 2001.

Kazimirski, M., C. Renaud, et al. Computer Literacy and Electronic Medical Records, The College of Family Physicians of Canada, 2000.

Kleinke, J. D. "Release 0.0: clinical information technology in the real world." *Health Aff (Millwood)* 17(6): 23-38, 1998.

Korpman, R. A. "Managed care and e-health." *Health Manag Technol* 22(2): 12-4, 2001.

Krall, M. A. "Acceptance and performance by clinicians using an ambulatory electronic medical record in an HMO." *Proc Annu Symp Comput Appl Med Care:* 708-11, 1995.

Kudla, K. M. and M. C. Rallins. "SNOMED: a controlled vocabulary for computer-based patient records." *J AHIMA* 69(5): 40-4; quiz 45-6, 1998.

Landro, L. "Terrorist Attacks Highlight Need for Electronic Medical Records." *Global Work/Life Solutions,* 2001.

Lindberg, D. A. and B. L. Humphreys. "Medical informatics." *JAMA* 275(23): 1821-2, 1996.

Lippman, H. "Making the move to electronic records - Some small practices are going electronic. The key is to keep it simple." *Hippocrates,* 2000.

Liu, G. C., J. G. Cooper, et al. "Standards for the electronic health record, emerging from health care's Tower of Babel." *Proc AMIA Symp:* 388-92, 2001.

Loomis, G. A., J. S. Ries, et al. "If electronic medical records are so great, why aren't family physicians using them?" *J Fam Pract* 51(7): 636-41, 2002.

Lorence, D. P., A. Spink, et al. "EPR adoption and dual record maintenance in the U.S.: assessing variation in medical systems infrastructure." *J Med Syst* 26(5): 357-67, 2002.

Lowes, R. "EMR? Not exactly. Good enough? For now." *Med Econ* 79(15): 32-4, 2002.

Marietti, C. "Building the empire. CORBAMed focuses on goals of connectivity and interoperability." *Healthc Inform* 15(2): 39, 1998.

Marietti, C. "Extensibility sensibility. Is XML the solution for electronic medical records data exchange?" *Healthc Inform* 15(3): 23-6, 1998.

Marietti, C. "The eyes have it. CCOW (Clinical Context Object Workgroup) brings both cooperation and competition together to tackle visual integration." *Healthc Inform* 15(6): 39, 1998.

Marietti, C. "Finger pointing. Who's to blame for the lack of standards?" *Healthc Inform* 15(7): 32, 1998.

Marietti, C. "Love, love? Hardly, as ActiveX and CORBA volley for leadership." *Healthc Inform* 15(11): 55-6, 58, 62-4, 1998.

Marietti, C. "A modern LOINC (Logical Observation Identifier Names and Codes)." *Healthc Inform* 15(8): 28, 1998.

Marietti, C. "The VA takes a stand. Adopted standards are the only standards." *Healthc Inform* 15(1): 35, 1998.

Marietti, C. "Will the real CPR, EMR, EHR please stand up? As healthcare turns its attention to automating patient information, the debate over the CPR heats up." *Healthc Inform* 15(5): 76-81, 1998.

Marietti, C. "Writing to the rules. If you're looking at a clinical decision support system, it had better be Arden Syntax compliant." *Healthc Inform* 15(3): 17, 1998.

Massaro, T. "Introducing Physician Order Entry at a Major Academic Medical Center: Impact on Medical Education." *Acad Med* 69: 25-30, 1993.

Massaro, T. "Introducing Physician Order Entry at a Major Academic Medical Center: Impact on Organizational Culture and Behavior." *Acad Med* 68: 20-25, 1993.

McCarthy, J. "Healthy Challenges." *InfoWorld,* 2002.

McDonald, C. J. "Need for standards in health information." *Health Aff (Millwood)* 17(6): 44-6, 1998.

McDonald, C. J., J. M. Overhage, et al. "The Regenstrief Medical Record System: a quarter century experience." *Int J Med Inf* 54(3): 225-53, 1999.

McGuire, M. R. Appendix: Healthcare Standards. *Automation of the Patient Medical Record: Steps Toward a Universal Patient Record,* 2001.

Medical Group Management Association. Medical Group Management Association Survey, 2001.

Medical Record Institute. 4th Annual Medical Record Institute's Survey of Electronic Health Record Trends and Usage (sponsored by SNOMED), 2002.

Metzger, J. and F. Turisco. Computerized Physician Order Entry: A Look at the Vendor Marketplace and Getting Started, First Consulting Group. 2001.

National Committee on Vital and Health Statistics. Report to the Secretary of the U.S. Department of Health and Human Services on Uniform Data Standards for Patient Medical Record Information, 2000.

National Library of Medicine and Agency for Health Care Policy and Research,

"Minutes: Vocabularies for Computer-based Patient Records: Identifying Candidates for Large Scale Testing," Bethesda, MD, 1994.

Office of Health and the Information Highway - Health Canada. "International Activities Toward Electronic Health Records: Unique Identification and PKI," 1998.

Overhage, J. M., S. Perkins, et al. "Controlled trial of direct physician order entry: effects on physicians' time utilization in ambulatory primary care internal medicine practices." *J Am Med Inform Assoc* 8(4): 361-71, 2001.

Penrod, L. E. and C. S. Gadd. "Attitudes of academic-based and community-based physicians regarding EMR use during outpatient encounters." *Proc AMIA Symp:* 528-32, 2001.

Pollard, D. L. and W. E. Hammond. "Object technology: raising the standards for healthcare information systems." *Medinfo* 9 Pt 1: 217-21, 1998.

Randell, C. L., C. N. Bero, et al. "Benefits of the worldwide government computer-based patient record framework." *J Healthc Inf Manag* 12(4): 39-51, 1998.

Rehm, S. and S. Kraft. "Electronic medical records: the FPM vendor survey." *Fam Pract Manag* 8(1): 45-54, 2001.

Ringold, D. J., J. P. Santell, et al. "ASHP national survey of pharmacy practice in acute care settings: dispensing and administration-1999." *Am J Health Syst Pharm* 57(19): 1759-75, 2000.

Rogoski, R. R. "The ABCs of CPRs and EMRs. Definitions, semantics, product differences and the need for demonstrated results hinder wide-scale adoption." *Health Manag Technol* 23(5): 14-6, 19, 2002.

Rogoski, R. R. "Dueling platforms." *Health Manag Technol* 23(8): 36-8, 2002.

Safyer, S. "Highly evolved: Montefiore Medical Center rolls out CPOE gradually, successfully." *Modern Physician,* 2003.

Safran, C. "Electronic medical records: a decade of experience." *JAMA* 285(13): 1766, 2001.

Scott, L. "Point of contact." *Modern Physician,* 2000.

Shahar, Y. Presentation: Computer-based Patient Records and Medical Informatics Standards.

Sicotte, C., J. L. Denis, et al. "The computer based patient record: a strategic issue in process innovation." *J Med Syst* 22(6): 431-43, 1998.

Sittig, D. F., G. J. Kuperman, et al. "Evaluating physician satisfaction regarding user interactions with an electronic medical records system." *Proc AMIA Symp:* 400-4, 1999.

Staggers, N. "The vision for the Department of Defense's computer-based patient record." *Mil Med* 165(3): 180-5, 2000.

Stringer, J. Broken Records. *Red Herring Magazine,* 2000.

Tang, P. C. Testimony to the NCVHS Workgroup on Computer-based Patient Records, 1998.

Teich, J. M., J. P. Glaser, et al. "The Brigham integrated computing system (BICS): advanced clinical systems in an academic hospital environment." *Int J Med Inf* 54(3): 197-208, 1999.

"U.S. Trails Other English Speaking Countries in Use of Electronic Medical Records and Electronic Prescribing." *Harris Interactive Health Care News* 1(28), 2001.

Versel, N. "CPOE without culture change may increase drug errors." *Modern Physician,* 2003.

Voelker, K. G. Primer on Electronic Medical Records.

Waegemann, C. P. Status Report 2002: Electronic Medical Records, Medical Records Institute, 2002 .

Winn, D. "EMR: Not Just a Question of When but a Question of How." *Group Practice Journal,* 2002.

Yasnoff, W. A., J. M. Overhage, et al. "A national agenda for public health informatics." *J Public Health Manag Pract* 7(6): 1-21, 2001.

Appendix: Meta-Analysis of CPR Studies

Study	Sponsor	Time Frame	Methodology	Respondents	Generalizeable
13th Annual Healthcare Information and Management Systems Society (HIMSS) Leadership Survey	**Professional Society:** HIMSS **Consulting Firm:** Superior Consultant Company	11/19/01–1/6/02	**Voluntary Mail/Email Survey:** Over 4,000 chief information officers (CIOs) at healthcare facilities around the country were contacted via email and U.S. mail to participate in a voluntary, self-administered, web-based questionnaire. (Data were solicited from only one individual per healthcare organization unlike previous years' surveys.)	**Sample Size (N):** 355 respondents representing 355 healthcare provider organizations. **Profile:** 47% of respondents represented stand-alone hospitals while 43% were part of a multi-hospital system or network. 80% of respondents represented not-for-profit organizations. Geographically, most respondents came from organizations located in the Mountain, East North Central, and South Atlantic regions of the country. New England had the lowest number of respondents.	Unknown.
HIMSS Hot Topics Survey, 2002	**Professional Society:** HIMSS	1/27/02–1/31/02	**Voluntary Conference Survey:** Attendees, exhibitors, and exhibitor guests at the Annual HIMSS Conference and Exhibition held in Atlanta, Ga., January 27-31, 2002, were given the opportunity to complete this survey administered on hand-held devices.	**Sample Size (N):** 619 respondents. **Profile:** 71% of respondents worked in healthcare provider organizations. ~33% of respondents were chief executive officers, chief information officers, or chief financial officers. Another 44% were management or department heads/directors while 11% identified themselves as staff.	Not generalizeable.
HIMSS/Astra Zeneca Clinician Wireless Survey, 2002	**Professional Society:** HIMSS, Medical Group Management Association (MGMA), American Medical Group Association (AMGA), Association of Medical Directors of Information Systems (AMDIS) **Pharmaceutical:** AstraZeneca	8/8/02–8/26/02	**Voluntary Survey:** Approximately 800 physician members of AMDIS and executive and practice manager members of MGMA and AMGA were invited to participate in this survey.	**Sample Size (N):** 453 useable responses. **Profile:** The majority of respondents (~61%) came from organizations with less than 10 FTE physicians. 25% of respondents represented organizations with greater than nine FTE physicians, while 20% came from organizations with one to two FTE physicians at their primary location.	Unknown.

Appendix: Meta-Analysis of CPR Studies (cont)

Study	Sponsor	Time Frame	Methodology	Respondents	Generalizeable
MediNetwork 2002 Medical Group Office Management Systems Survey	**Consulting Firm:** MediNetwork	4/1/02–6/13/02	**Voluntary Mail Survey:** Surveys were mailed to the managing partner or administrator at 4,000 randomly selected physician group practices with three or more physicians. These practices, which were distributed across 40 states, included a variety of specialties such as family practice, internal medicine, orthopedic surgery, cardiology, ophthalmology, radiology, anesthesiology, gastroenterology, and urology.	**Sample Size (N):** 301 respondents (7.52% response rate). **Profile:** 35% of respondents represented practices with six to 10 physicians, while 27% had five or fewer physicians. 17% had 21 or more physicians, while 14% had 11-15 physicians, and 7% had 16-20 physicians.	Unknown.
AHA Most Wired Survey, 2002	**Professional Society Journal:** American Hospital Association (AHA)'s journal, *Hospitals and Health Networks* **Professional Society:** HIMSS **Industry Vendor:** McKesson Information Solutions, Qwest Communications International	2002	**Online Voluntary Survey:** The 8-page web-based survey was publicized in a variety of publications including *Hospitals and Health Networks, AHA News, AHA News Now, and HIMSS News.* Announcements were also mailed to all U.S. hospitals. Hospital executives were offered the option of submitting their completed surveys online or by printing them out and mailing them manually.	**Sample Size (N):** 306 responses representing 794 acute care hospitals. **Profile:** Respondents represented ~14% of U.S. hospitals and were well-dispersed geographically. Hospitals participating in the survey tended to be larger and more urban than the national average.	Not applicable.
Fourth Annual Medical Record Institute's Survey of Electronic Health Record Trends and Usage sponsored by SNOMED	**Industry Advocate:** Medical Records Institute **Industry Vendor:** SNOMED	4/15/0 –5/16/02	**Voluntary Survey:** 1,131 individuals responded to the survey; however, 370 responses from vendors, consultants, and payers were eliminated to reduce bias in the survey results.	**Sample Size (N):** 761 useable responses. (Responses received varied by survey question: CPR adoption rates by functionality received 717 responses; barriers to CPR adoption received 477 responses; use rates of clinical data entry methods received 507 responses; use and rate of adoption of standards received 550 responses.)	Not generalizeable.

Appendix: Meta-Analysis of CPR Studies (cont)

Study	Sponsor	Time Frame	Methodology	Respondents	Generalizeable
				Profile: About half of respondents worked at hospitals, while 14% worked in medium or large group practices (greater than nine physicians). 12% of respondents represented solo or small group practices (fewer than nine physicians), and another 12% belonged to integrated health delivery service organizations.	
Leapfrog Group Survey, 2001	**Independent Agency:** Leapfrog Group	Late summer and fall of 2001.	**Voluntary Survey:** Surveys were submitted to 497 urban hospitals in California, Minnesota, East Tennessee, Atlanta, St. Louis, and the Seattle-Tacoma-Everett area.	**Sample Size (N):** 241 respondents (48% response rate). **Profile:** Variable response rates were witnessed across the different regions sampled. (e.g. Almost all invited hospitals in East Tennessee participated in the survey, whereas only one out of 31 hospitals in St. Louis participated.)	Not generalizeable.
Medical Group Management Association (MGMA) Survey, 2001	**Professional Society:** MGMA **Industry Vendor:** Pfizer Health Solutions, Inc.	2001	**Random Internet and telephone survey:** The survey was administered through the Internet and over the telephone to a random sample of the MGMA membership.	**Sample Size (N):** 593 respondents. **Profile:** The majority of respondents (76%) belonged to group practices, while 11% belonged to community health centers and 3% worked at academic practices. The remaining 9% represented other healthcare organizations. 58% of respondents worked at practices with 10 or fewer FTE physicians. 27% belonged to practices with 11-50 FTE physicians, and 15% belonged to practices with greater than 50 FTE physicians.	Generalizeable.

Appendix: Meta-Analysis of CPR Studies (cont)

Study	Sponsor	Time Frame	Methodology	Respondents	Generalizeable
Modern Physician/ Pricewaterhouse Coopers Survey, 2002	**Trade Journal:** *Modern Physician* **Consulting Firm:** Pricewaterhouse Coopers	2002	**Voluntary Internet Survey**: The survey was administered online at *Modern Physician's* website.	**Sample Size (N):** 444 respondents. **Profile:** Respondents consisted of physician executives and healthcare IT professionals.	Not generalizeable.
Modern Physician/ Pricewaterhouse Coopers Survey, 2002	**Trade Journal:** *Modern Physician* **Consulting Firm:** Pricewaterhouse Coopers	2001	**Voluntary Internet Survey**: The survey was administered online at *Modern Physician's* website.	**Sample Size (N):** Not specified. **Profile:** Not specified.	Not generalizeable.
Modern Physician/ Pricewaterhouse Coopers Survey, 2000	**Trade Journal:** *Modern Physician* **Consulting Firm:** Pricewaterhouse Coopers	2000	**Voluntary Survey**: The survey was administered to *Modern Physician* readers.	**Sample Size (N):** 809 respondents. **Profile:** Respondents consisted of physician group executives.	Not generalizeable.
Modern Physician/ Pricewaterhouse Coopers Survey, 1999	**Trade Journal:** *Modern Physician* **Consulting Firm:** Pricewaterhouse Coopers	1999	**Voluntary Survey**: Not specified.	**Sample Size (N):** 993 respondents. **Profile:** Not specified.	Not generalizeable.
Modern Physician/ Pricewaterhouse Coopers Survey, 1998	**Trade Journal:** *Modern Physician* **Consulting Firm:** Pricewaterhouse Coopers	1998	**Voluntary Survey**: Not specified.	**Sample Size (N):** Not specified. **Profile:** Not specified.	Not generalizeable.
Harris Interactive, 2002	**Market Research/ Consulting Firm:** Harris Interactive	European data taken from June-July 2001. American data taken in June 2000.	**Survey:** The numbers for European countries were taken from the Euro Barometer 104 conducted in June-July 2001 and published by the European Union. The survey was based on interviews with 3,504 general practitioners in the 15 European Union countries. The American data was based on a survey of primary care physicians conducted in June 2000.	**Sample Size (N):** 3,504 participants in Europe. (The sample sizes varied from 400 in France to 150 in Finland to 80 in Luxembourg.) 377 participants in the U.S. **Profile:** The participants surveyed in Europe were general practitioners. The participants surveyed in the U.S. were primary care physicians, which includes specialists who provide primary care.	Unknown.

Appendix: Meta-Analysis of CPR Studies (cont)

Study	Sponsor	Time Frame	Methodology	Respondents	Generalizeable
Harris Interactive/ Boston Consulting Group	**Market Research/ Consulting Firm:** Harris Interactive **Consulting Firm:** Boston Consulting Group	Not specified.	**Survey:** Methodology not specified.	**Sample Size (N):** 400 respondents. **Profile:** Respondents consisted of physicians.	Unknown.
Harris Interactive, 2001	**Market Research/ Consulting Firm:** Harris Interactive **Academic Institution:** Harvard School of Public Health **Private Foundation:** Commonwealth Fund's International Health Care Symposium	2000	**Survey:** Not specified.	**Sample Size (N):** Not specified. **Profile:** Not specified.	Unknown.
Ringold DJ, Santell JP, Schneider PJ. ASHP national survey of pharmacy practice in acute care settings: dispensing and administration—1999. *Am J Health Syst Pharm.* Oct 1 2000; 57(19):1759-1775.	**Academic Paper:** *Am J Health Syst Pharm*	1999	**Voluntary Mail Survey:** Surveys were mailed to 1,050 pharmacy directors at general and children's medical-surgical hospitals in the U.S.	**Sample Size (N):** ~536 responses (51% response rate). **Profile:** Respondents consisted of pharmacy directors at general and children's medical-surgical hospitals in the U.S.	Generalizeable to pharmacy directors at general and children's medical-surgical U.S. hospitals.
Loomis GA, Ries JS, Saywell RM, Jr., Thakker NR. If electronic medical records are so great, why aren't family physicians using them? *J Fam Pract.* Jul 2002;51(7): 636-641.	**Academic Paper:** *J Fam Pract.*	2001	**Voluntary Mail Survey:** Surveys, consisting of 53 pre-tested questions based on the 1991 IOM report, were mailed to active members in the Indiana Academy of Family Physicians (IAFP) 2000-2001 membership database in January 2001. Nonrespondents were mailed a follow-up reminder three weeks later.	**Sample Size (N):** 618 useable responses. **Profile:** Respondents consisted of active members in the IAPF who were practicing in Indiana and spent four or more hours a week seeing patients.	Generalizeable to IAFP members.

Appendix: Meta-Analysis of CPR Studies (cont)

Study	Sponsor	Time Frame	Methodology	Respondents	Generalizeable
Lorence DP, Spink A, Richards MC. EPR adoption and dual record maintenance in the U.S.: assessing variation in medical systems infrastructure. *J Med Syst.* Oct 2002;26(5): 357-367.	**Academic Paper:** *J Med Syst*	June 1998– May 1999	**Survey:** Data from a nationwide survey of information managers accredited by the American Health Information Management Association served as the basis for the study. Samples for the pre-tested survey were taken from a database of certified health information managers provided by the Foundation for Record Education (FORE).	**Sample Size (N):** 16,591 respondents (50.4% gross response rate). **Profile:** Respondents consisted of health information managers from a variety of practice settings and excluded students. Practice settings included hospitals and medical centers, group practices, ambulatory care clinics, long-term care and rehabilitation facilities, colleges and universities, consulting firms, government agencies, software product companies, pharmaceutical companies, self-employed HIM professionals, and other work settings.	Unknown.
Ash JS, Gorman PN, Hersh WR. Physician order entry in U.S. hospitals. *Proc AMIA Symp.* 1998:235-239.	**Symposium Paper:** *Proc AMIA Symp. 1998*	Not specified.	**Random Voluntary Mail/Telephone Survey:** A four-question survey was mailed to a random sample of 1,000 accredited hospitals listed in the 1997 American Hospital Association Guide. A follow-up mailing was sent to non-respondents. To ensure that nonrespondents were not significantly different from respondents, a random sample of non-respondents was taken and administered the survey verbally over the phone. Surveys were addressed to the chief executive officers of the hospitals but were encouraged to transmit the survey to appropriate person in the organization.	**Sample Size (N):** 324 respondents. (33% response rate – 983 of the 1,000 addresses were correct.) **Profile:** 36% of respondents were CEOs or presidents. 30% were information system staff. 14% were chief information officers or vice presidents, and 26% were unspecified.	Generalizeable.

Appendix: Meta-Analysis of CPR Studies (cont)

Study	Sponsor	Time Frame	Methodology	Respondents	Generalizeable
Wall Street Journal, June 25, 2002	**Media:** *Wall Street Journal*	Not specified.	**Survey:** Not specified.	**Sample Size (N):** Not specified. **Profile:** Not specified.	Unknown.
Lippman H. Making the move to electronic records—Some small practices are going electronic. The key is to keep it simple. *Hippocrates.* 2000.	Trade Journal: *Hippocrates* (ceased in March 2001)	Not applicable.	**Recall:** Based on an interview with Leonard Fromer, MD, chair of one of the American Academy of Family Physicians' (AAFP) work groups on medical informatics.	**Sample Size (N):** Not applicable. **Profile:** Family physicians.	Not generalizeable.

Endnotes

1. CPRI 1996; Dick, Steen et al. 1997; Tang and Hammond 1997; Rehm and Kraft 2001; BPHC 2002; Waegemann 2002).
2. We could find little data on CPR adoption in surgery centers, and interviews that we conducted with surgery center leaders could not identify any objective data about CPR adoption rates in these settings.
3. The Health Resources and Services Administration, Bureau of Primary Health Care (BPHC).
4. "Computer-based Patient Record System Description of Functionality," CPRI Work Group on CPR Description, August 1996.