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Review Paper

Countdown to 2001: The Computer-based Patient Record After the Institute of Medicine Report

Abstract: A 1991 Institute of Medicine report called computer-based patient records (CPRs) an essential technology for health care and recommended widespread implementation of CPRs within a decade. Although a broader understanding of CPRs has been achieved and more leadership for CPR development exists today, substantial work remains to be accomplished. Critical tasks include developing a detailed specification of the CPR concept, strengthening standards development efforts through greater federal funding and involvement, developing national policy on key issues, and identifying funding sources for CPR system implementation. This article reviews the major views and issues of the 1991 IOM report and relates them to subsequent developments.

Keywords: Computer-based Patient Records

Introduction

In 1991, an Institute of Medicine (IOM) committee declared computer-based patient records (CPRs) an essential technology for health care and called for widespread CPR implementation within a decade [1]. This ambitious recommendation was particularly striking when contrasted with the committee's conclusion that "no operational clinical information system in 1990 can manage the entire patient care record with all its inherent complexities" [1, p. 56]. After studying the health care environment, patient record user needs, technology, and barriers to CPR development, the IOM patient record committee concluded that: (1) health care was in desperate need of CPRs, (2) despite the status of current systems, technology was not the limiting factor in CPR development, and (3) a concerted effort could make CPRs a reality sooner rather than later. Thus, in addition to recommending that health care professionals and organizations adopt the CPR as the standard for patient records, the IOM report presented a road map for CPR development which included establishing an organization to promote development, implementation, and dissemination of CPRs; research and development in critical technologies for the CPR; promulgation of data and security standards; federal and state laws and regulations; sharing costs of CPRs; and educating health care professionals [1]. As the mid-point of the decade for CPR development and implementation approaches, it is appropriate to revisit the forces behind, the vision for, and the issues surrounding CPRs; review progress made since the release of the IOM report; and reinforce what remains to be accomplished.

Environmental Forces

Technological progress and increasing acceptance of computers by patients and practitioners increase the likelihood of achieving full-fledged CPRs. So too do the need for patient data to perform virtually any task associated with health care delivery and the challenges associated with managing and transferring the patient information generated by an aging and mobile population. The health care reform debate of 1993-1994 recog-

nized CPRs as a viable mechanism for improving patient data and an essential component of the health care infrastructure [2,3]. The penetration of managed care and the increasing prevalence of capitation in the United States are creating ever stronger pressure for adequate information to manage the health care delivery process and are strong forces driving CPR development [4-6].

These environmental forces are helping to override some of the barriers to CPR development. For example, the market-driven changes in the health care sector are altering the autonomous nature of health care delivery in the U.S. and the diffusion of computer technology combined with greater need for information are making clinicians both more willing and able to use CPRs. Other barriers - the lack of a clear definition of CPRs, a leadership gap with respect to CPRs, system costs, legal issues and social concerns (i.e., privacy), and infrastructure needs [1,7,8] - require more direct action. Varying degrees of progress can be reported on these fronts, but much remains to be accomplished.

The CPR Concept

The term "computer-based patient record" conveys two important aspects of the IOM committee's vision for medical records. First, the record is focused on and integrated around the patient -- across settings of care, across disciplines, and across time. Second, the record is computer-based not computerized; true CPRs are more than automated versions of current patient records. CPRs are a resource with much enhanced utility in patient care, management, and extension of knowledge. Thus, CPRs must reside in systems that support users by offering complete and accurate data as well as tools to aid the clinical decision process. CPRs should be the core of institutional or enterprise health care information systems and will eventually contribute to a national health care information system.

Achieving greater performance in data capture and retrieval capabilities and providing new functionality in decision support are vital if CPRs are going to impact the process of care. Equally important is direct interaction of clinicians with the CPR system so that they can benefit from the system's functions (e.g., reminders and alerts) as well as improve data quality and minimize delay in data availability. Recognition of the many users of patient records (including the patient) and of the role that CPRs must play in health care is crucial to understanding the CPR concept. CPRs are a critical resource beyond the patient-clinician encounter because they can provide the patient data to support health services research and macro and micro level decisions throughout health care ranging from the development of clinical practice guidelines to the allocation of resources within and among institutions and communities to determining high quality, cost effective providers.

According to the IOM committee, comprehensive CPRs and CPR systems should (1) contain a problem list; (2) support systematic measurement of health status and functional level; (3) document the clinical rationale for patient care decisions; (4) link to other clinical records across settings and across time to provide a longitudinal record; (5) provide comprehensive confidentiality safeguards; (6) offer easy access to authorized users; (7) allow selective retrieval and formatting of information; (8) link to local and remote knowledge, literature, bibliographic, or administrative databases and systems; (9) assist in the clinical problem solving process; (10) support structured data collection and store data using a defined vocabulary as well as support direct data entry by practitioners; (11) aid in the management and evaluation of quality and costs of care; and (12) be flexible and expandable. No single CPR system will meet the needs of all settings; all CPR systems must, however, meet minimum connectivity standards and offer a set of standard functions that meet the criteria listed above.

Several signs of progress toward this vision are evident. The concept has been broadly disseminated. Over 10,500 copies of the IOM report have been sold. The CPR has been highlighted at many conferences and is frequently addressed in the literature. The term "computer-based patient record" is increasingly (although not exclusively) used in the health care vernacular. Some people are uncomfortable with the use of the term patient in CPR because they think it over-emphasizes illness care at the expense of health care. They prefer the broader term citizen. There is not a sufficiently precise word in English to describe the relationship of a healthy person to the health care system. Perhaps this absence exists because until recently there was so little medical professionals could offer in terms of worthy preventive measures. Consumer is too generic and does a disservice to what the individual brings to the care setting; client has overtones of legal practice. The IOM committee clearly viewed the CPR as a longitudinal record which relates to the citizen in times of health as well as illness, for health maintenance as well as illness care.)

The vision for patient records articulated in the IOM report has been generally accepted and reinforced in subsequent work [9-15]. Recent studies have validated that there is significant room for improvement in patient data availability and that decision aids and other CPR functions can reduce resource utilization [16-19]. Several insurers consider CPRs to offer sufficient tangible benefits to reduce liability insurance premiums for physicians [20].

Individual health care provider institutions and systems are making strides towards fully developed CPRs [21-23]. In April 1995, Intermountain Health Care, Columbia Presbyterian Medical Center, and the Veterans Administration were recognized for excellence in

various aspects of CPR system development and implementation at the first annual Davies Symposium organized by the Computer-based Patient Record Institute. Progress is being made outside the U.S. toward CPR implementation as well (e.g., the Netherlands and Great Britain) [24,25]. The attributes of CPRs defined by the IOM are guiding vendors in their system development. The CPR has been described as moving from the realm of "off-beat visionaries" and the view that it was too difficult to even attempt, to an "establishment-endorsed probability" [26, p. 265] which is "a component of most strategies for the provision of medical care to large populations" [23, p. 293].

Several cautionary flags must, however, be raised. First, CPRs must be clinically based and clinically driven. Automated abstracts of patient records are not adequate to meet patient record needs. At the same time, more data should not be captured just because technology makes it easier to do so. Part of the design process for CPRs must involve defining record content and redesigning record format [27,28]. Moreover, the form of data captured is critical; merely computerizing text is not sufficient to meet CPR requirements [29-32]. Most importantly, the CPR concept has not been articulated fully. Greater specificity in the definition, architecture, and functional capabilities of CPRs is urgently needed to guide developers, vendors and purchasers of CPR systems.

In February 1995, the Computer-based Patient Record Institute convened the first meeting of its Work Group on CPR Description which is charged to articulate a complete, nonprescriptive definition of the CPR and CPR systems. The work group plan calls for development of increasingly detailed documents that will include a general vision, information framework, CPR system functionality, CPR content, and standards requirements. This group as well as the International Medical Informatics Association's working groups on health information systems and workstations are likely to expedite progress on the CPR definition [10,33]. This effort also will benefit from stronger relationships between clinicians and vendors than currently exist; the U.S. could learn from the success of the Netherlands where professional societies have played an active role in formulation of system requirements [24,32].

Leadership

Leadership for CPR development can now be found in both the private and public sectors. In the private sector, the most visible sign of leadership related to CPRs was the formation of the Computer-based Patient Record Institute (CPRI), a non-profit membership organization with representation from throughout health care. The mission of the CPRI is to initiate and coordinate activities that promote the routine use of CPRs throughout health care. Its work is conducted primarily through 5 work groups (Codes and Structures; Confidentiality, Privacy and Security; Systems Evaluation; Professional and Public Education; and Description).

During its three years of existence, CPRI has succeeded in creating a focal point for CPR development. In addition to its general meetings (which are open to non-members), CPRI publishes a newsletter, has prepared position papers on a variety of issues (e.g., standards, authentication, and access), developed a compendium of the literature related to CPRs, drafted evaluation criteria for CPRs, and organized a symposium to recognize excellence in various aspects of CPRs and disseminate lessons learned from organizations which have experienced success in CPR development. To date, CPRI has focused its efforts on addressing the major barriers to CPR development (e.g., standards acceleration, security) rather than on the development of CPR applications. This trend is likely to continue, as is CPRI's heavy emphasis on organized collaboration as the means to expedite progress. As CPRI matures, it is striving to refine and broaden understanding of the CPR concept, increase recognition of CPRs as essential enablers for integrated health care systems, and accelerate standards crucial to CPRs.

The work of CPRI is complemented by the Healthcare Open Systems and Trials (HOST) which is a consortium established to accelerate the development and deployment of integrated and interoperable health care information systems. While CPRI focuses on policy and evaluation and what needs to accomplished (e.g., concept and standards), HOST focuses on how systems will be implemented (e.g., telecommunications, integration techniques, tools, and systems framework). CPRI and HOST have a formal relationship and coordinate their work to avoid duplication and maximize the benefits of their respective efforts [34].

Although the leadership is more diffuse than in the private sector and the focus not exclusively CPR-driven, several federal agencies have made important contributions toward CPR development. The National Library of Medicine (NLM) continues to play a pivotal role by helping medical institutions make connections to the Internet, supporting training in medical informatics training and High Performance Computing and Communications (HPCC) technologies, and developing and maintaining the Unified Medical Language System. NLM was also the first component of the National Institutes of Health to participate in the HPCC program. In 1994, NLM and the Agency for Health Care Policy and Research (AHCPR) provided funding to 8 CPR development testbeds to evaluate a variety of issues related to CPRs (e.g., standards, vocabularies, guidelines, security, user acceptance, cost-benefit analysis) [35]. AHCPR has been working to facilitate coordination among organizations

developing standards in the U.S. and internationally [36]. The pace of efforts by AHCPR has clearly quickened in the early tenure of the new agency head. The Department of Health and Human Services formed a Computerized Patient Record Council in 1992. Both the Department of Defense and Department of Veterans Affairs continue to develop and implement components of CPRs [37,38].

There appears to be greater coordination and consensus than in the past among federal agencies with respect to CPR-related activities. This can be attributed in large measure to the leadership of individuals in key roles including the assistant secretary of health and the initial director of the HPCC. The U.S. federal government's approach to promoting CPR development is still markedly different from that of other countries (e.g., the Netherlands, Great Britain) where financial incentives for CPR systems have been provided [25,26]. Although there appears to be substantial enthusiasm within most branches of the government with respect to the value and necessity of the CPR and CPR systems and a good relationship exists between the public and private sectors on CPR development, the federal government has been slow to invest financial resources directly in CPRI to allow it to develop fully. Discussions between government officials and the CPRI have been initiated as of this writing. As discussed below, there is also room for more federal support of and involvement in standards development activities and policy development on specific issues needs attention.

Specific Challenges

CPR component technologies continue to develop at a rapid pace. Perhaps most importantly, significant progress is being made in the area of user interfaces and data acquisition. Clinical workstations are increasingly robust so that they provide clinicians with ever greater incentives to interact with the computer and the CPR system. Pen and pad technology as well as portable workstations are already being used to offset previously observed resistance to data entry. Handwriting and speech recognition also loom on the horizon as potential aids to data acquisition, but their actual value remains to be determined. Whatever form the user interface takes, more attention to human-computer interface is needed in the design of CPR systems [39].

Considerable progress has also been achieved with respect to establishing the information infrastructure that is essential to CPR system functionality. This information infrastructure will not only provide access to a multitude of information resources but also will enable transmission of patient data among institutions. Although much of the back bone of this infrastructure (through Internet, commercial online services, community health information networks, and telemedicine networks) is in place or being built, connections still remain to be made to remote locations and even within health care provider institutions. The importance of the communications infrastructure to optimal functioning of CPRs has not been fully appreciated and should receive more attention within institutions and industry at-large. Interest in telemedicine at the federal level may spur more progress in this area.

There has been both increased activity in standards development both in Europe and the U.S. and greater effort to coordinate standards development [4,10,40]. For example, the American National Standards Institute (ANSI) formed the Health Care Informatics Standards Planning Panel (HISPP) in 1991 to address issues related to vocabulary, messaging, and security standards. In October 1994, ANSI HISPP met with its European counterpart (CEN TC/251) to discuss international standards development [36]. Health Level 7 (HL-7) is increasingly accepted as the connectivity standard for clinical information systems. In the realm of vocabulary standards, new editions of SNOMED and Read Clinical Classification show great promise for clinical data and the UMLS Metathesaurus has been expanded substantially.

In the U.S., however, standards development generally still relies on volunteers who fund their own efforts. To date, attempts to elevate standards through legislation have not succeeded and the likelihood of future success is uncertain. The current rate of progress in standards development is not adequate and has implications for public health as well as progress in CPR system development. Unless standard terms are developed and universally applied, longitudinal records and aggregate data bases will have less consistency in meaning and less usefulness to patient care professionals and researchers. Standards efforts require additional funding, more explicit recognition through adoption of standards by major players (e.g., federal agencies), and ratification through legislation. There is clearly a pressing need for greater federal involvement in this area.

Resources available for CPR research have increased significantly since 1991. Less evident is support for system implementation across health care settings. Unlike the Netherlands, the U.S. does not provide financial incentives for physicians to use CPR systems. Nor have other beneficiaries of CPRs (e.g., third party payers) stepped forward to provide financial support for CPR implementation.

Market forces and the move to capitation may make CPR investment more likely in the future as health care providers may use integrated information systems based on CPRs as a competitive strategy for streamlining their op-

erations and gathering fine-grain data for comparison against their peers. At the same time, however, capitation does not require information about services provided for reimbursement and some health care providers may see this as an opportunity to reduce their investment in CPRs and information systems. Given the importance of CPRs, CPR systems, and a health information infrastructure to achieving fundamental reforms in health care, federal and state governments should monitor this issue closely. A more aggressive funding policy may be needed if CPR system implementation does not go far enough or fast enough with current market incentives.

Evaluation of evolving CPR systems and CPR-related systems is now underway with both federal and private sector support. Although benefits of specific systems in specific settings have been documented, the costs and benefits of CPR systems within health care provider networks or regions remain to be established. As such evidence becomes available, it will likely strengthen the case for allocating resources to CPR and CPR related information systems across the health care industry and within specific institutions. Continued funding for evaluation is important, as is development of appropriate methodologies for conducting such evaluations [41].

Education about the concept of CPRs is well underway both within health care and with the public. Three key areas of education remain to be addressed. First, the demand for individuals trained in health informatics continues to outstrip the supply and therefore efforts to meet the demand must continue. Second, although information technology and training on its use is increasingly evident in health professional schools, overhaul of curricula to reflect the changing skills and competences future clinicians will need are not yet widespread. Third, although more distant from CPR development, as information technology continues to disseminate throughout society at-large there is increased likelihood that patients will access CPRs and therefore will need education in the use of the patient record and health information resources.

While significant advances have been made in CPRs and other information technology applications in health care, *national policy* lags. Policies are needed to deal with ownership of data, develop unique health identifiers, ensure adequate safeguards for protection of patient privacy, and clarify assignment of liability for problems arising with the use of clinical decision support systems. Lack of these policies slows development and failure to establish a national policy may result in the development of conflicting state policies that add tremendous hidden costs to CPR system implementation. In the immediate future, stiff clear national standards, set through federal legislation, are needed for confidentiality, security, and accuracy of CPRs and other health data sets [12]. Unique, citizen identifiers (such as a social security number accompanied by a confidential personal identifier number (PIN) of several digits) that can be used for health purposes would facilitate development of longitudinal patient records in CPR systems and in research data bases.

Conclusion: Toward 2001

Although the current state of CPR development can be most accurately described as having pockets of excellence rather than full market saturation, the signs of CPRs' arrival are far more promising than they were 5 years ago. Incremental progress is evident in almost all of the areas identified in the IOM report. Given the myriad tasks remaining to be accomplished to implement CPRs, however, priorities must be set to reach the next threshold of CPR development. Critical tasks to be accomplished include: articulating a detailed CPR concept (including architecture); buttressing standards efforts through greater federal funding and involvement; renewing the effort to develop national policy on key issues; and identifying funding for dissemination of successful systems.

At various times, a "moonshot" approach to CPR development has been proposed. Whether the momentum for such a program could be built in the current climate is uncertain at best. It is certain, however, that such an effort would have a lasting value not only to the U.S. but also around the world. As the title of the IOM report indicates, CPRs are essential to health care. Until and unless robust CPRs are developed and broadly implemented, we are limited in our capacity to develop truly integrated delivery systems, to make each and every clinical decision as effective as possible, and to reach health care's next plateau -- evidence-based medicine.

What will be the state of CPR implementation by 2001? CPR systems will continue to evolve. There will be a growing number of recognized robust CPR systems in use in various kinds of delivery settings. The kinds and levels of use of computer applications related to CPRs will expand. So too, the need for and expectations of CPRs and CPR systems will continue to grow. Will there be widespread CPR implementation by 2001? Probably no, unless a "moonshot" approach to CPR development suddenly emerges. Will there be widespread CPR implementation by 2010? Certainly yes.

Acknowledgements

In preparing this paper, we invited IOM patient record committee members and other individuals who contributed to the patient record study to comment on CPR progress since 1991. We would like to thank the following individuals for sharing their perspectives and insights with us: Margret Amatayakul, Marion Ball, Morris Collen, Richard Dick, Betsy Humphreys, Carmi Margolis (and his colleagues at Ben Gurion University of the Negev), and Paul Tang.

References

1. Institute of Medicine. Dick RS, and Steen EB, eds. *The Computer-based Patient Record: An Essential Technology for Health Care*. Washington, DC: National Academy Press, 1991.
2. Institute of Medicine. Field MJ, Lohr KN, and Yordy KD, eds. *Assessing Health Care Reform*. Washington, DC: National Academy Press, 1993.
3. U.S. House of Representatives. *HR 1200: American Health Security Act*. 1993.
4. Shortliffe EH. Health care professional workstations: Where are we now? ... Where should we be tomorrow? Int J Biomed Comp 1994;34:45-55.
5. Bergman R. Where there's a will... Computer-based patient records require commitment, time and money. Hospitals and Health Networks 1994;May:36-42.
6. Levesque G. 1994 HIMSS/Hewlett Packard leadership survey results. Healthcare Informatics 1994;July:44-8.
7. U.S. General Accounting Office. *Medical ADP Systems: Automated Medical Records Hold Promise to Improve Patient Care*. Washington, DC: General Accounting Office, 1991.
8. Rind DM and Safran C. Real and imagined barriers to an electronic medical record. In: Safran C, ed. *Proceedings of the Seventeenth Annual Symposium on Computer Applications in Medical Care*. New York: McGraw-Hill, 1993:74-8.
9. Work Group on Computerization of Patient Records. *Report to the Secretary, U.S. Department of Health and Human Services. Toward a national health information infrastructure*. 1993.
10. Bakker A, Hammond WE, Ball MJ. *Summary Report of Observations, Conclusions, and Recommendations: IMIA Working Group 10 Hospital Information Systems*. 1994.
11. Hammond, WE. Hospital information systems: a review in perspective. In: Van Bemmel JH and McCray AT, eds. *Yearbook of Medical Informatics: Advanced Communications in Health Care*. Stuttgart: Schattauer Verlag, 1994:95-102.
12. Institute of Medicine. Donaldson MS, and Lohr KN, eds. *Health Data in the Information Age: Use, Disclosure, and Privacy*. Washington, DC: National Academy Press, 1994.
13. Institute of Medicine. *America's Health in Transition: Protecting and Improving Quality*. Washington, DC: National Academy Press, 1994.
14. Rector AL, Nowlan WA, and Kay S. Foundations for an electronic medical record. Meth Inform Med 1991;30:179-86.
15. Computer-based Patient Record Institute, CPR Systems Evaluation Work Group. *Draft CPR Project Evaluation Criteria (version 1.0): The Nicholas E. Davies Recognition Program*. Schaumburg, IL: Computer-based Patient Record Institute, 1994.
16. Tang PC, Fafchamps D, and Shortliffe EH. Traditional medical records as source of clinical data in the outpatient setting. In: Ozbolt JG, ed. *Proceedings of the Eighteenth Annual Symposium on Computer Applications in Medical Care*. Philadelphia: Hanley & Belfus, 1994:575-9.
17. Tierney WM, Miller ME, Overhage JM, and McDonald CJ. Physician inpatient order writing on microcomputer workstations: effects on resource utilization. JAMA 1993;269:379-83.
18. Evans RS, Pestotnik SL, Classen DC, Horn SD, Bass SD, and Burke JP. Preventing adverse drug events in hospitalized patients. Ann Pharmacother 1994;28:523-7.
19. Borowitz SM. Using a computerized patient record to reengineer an outpatient clinic. In: Ozbolt JG, ed. *Proceedings of the Eighteenth Annual Symposium on Computer Applications in Health Care*. Philadelphia: Hanley & Belfus, 1994:286-90.
20. Borzo G. Physicians who computerize save on liability premiums. American Medical News February 1995.
21. Carpenter PC. The electronic medical record: perspective from Mayo Clinic. Int J Biomed Comp 1994;34:159-71.
22. Wykes A. Automating health care. Economist 1994;330: SS5-SS7.
23. Churgin PG. Introduction of an automated medical record at an HMO clinic. MD Comput 1994;11:293-300.
24. van der Lei J, Duisterhour JS, Westerhof HP, van der Does E, Cromme PVM, Boon WM, and van Bemmel JH. The introduction of computer-based patient records in the Netherlands. Ann Intern Med 1993;19: 1036-41.
25. Miller G, Britt H. Data collection and changing health care systems. Med J Australia 1993;159:471-6.
26. Duncan K. *Health Information and Health Reform: Understanding the Need for a National Health Information System*. San Francisco: Jossey-Bass Publishers, 1994.
27. Berwick DM. Eleven worthy aims for clinical leadership of health system reform. JAMA 1994;272:797-802.
28. Weed LL. New premises and new tools for medical care and medical education. Meth Inform Med 1989;28:207-14.
29. Essin DJ. Intelligent processing of loosely structured documents as a strategy for organizing electronic health care records. Meth Inform Med 1993;32:265-8.
30. Collen MF. The use of documents for computer-based patient records. Meth Inform Med 1993;32:269.
31. Rector AL. Marking Up is not enough. Meth Inform Med 1993;32:272-3.
32. Barnett GO, Jenders RA, Chueh HC. The computer-based clinical record - where do we stand? Editorial comment. Ann Int Med 1993;119:1046-8.
33. Silva JS and Ball MJ. The professional workstation as enabler: conference recommendations. Int J Biomed Comp 1994;34:3-10.
34. Heller E. What is HOST and how does it relate to CPRI? CPRI-MAIL 1994;3:2-3.
35. Lindberg DAB. Global information infrastructure. Int J Biomed Comp 1994;34:13-9.
36. Gaus C. Remarks of address at CPRI fall meeting. CPRI-MAIL 1994;3: 9-11.
37. Hudson T. Military maneuvers: DoD moves ahead with integrated clinical records. Hospitals 1993;67:28-9.
38. Hubbell PJ. The pharmacy as part of an integrated hospital information system: a focus on benefits. Hosp Pharm 1994;29:440-1,445-6,468.
39. Tang PC, and Patel VL. Major issues in user interface design for health professional workstations: summary and recommendations. Int J Biomed Comp 1994;34:139-48.
40. U.S. General Accounting Office. *Automated Medical Records: Leadership Needed to Expedite Standards Development*. Washington, DC: General Accounting Office, 1993.
41. van Bemmel JH. A model for the assessment of medical workstations for health care support. Int J Biomed Comp 1994;34:365-71.

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