Title

Difficulties Implementing an Electronic Medical Record for Diverse Healthcare Service Providers

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Difficulties Implementing an Electronic Medical Record for Diverse Healthcare Service Providers

Examining the failure of an EMR upgrade for the San Francisco Department of Public Health

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Abstract

To mitigate rising healthcare costs and FFS (Fee for Service) charges, large healthcare organizations are beginning to restructure their models for providing patient services. Many large healthcare organizations have implemented an Electronic Medical Record (EMR) to free the physical location of charts and automate existing business rules. This case study examines the failure of the San Francisco Department of Public Health's (SFDPH) attempts to upgrade their EMR system. While political, technological and economic barriers persist, the assumptions made by this proprietary EMR vendor did not reflect the diverse services provided by the organization. As a result, the implementation failed after two years of effort. Vendors of EMR systems need to incorporate flexibility by building modular components and incorporating standard messaging. This will provide the underlying architecture for service integration across all entities of healthcare.

Introduction:

The current expenditure of U.S. healthcare is 1.90 trillion dollars per year which roughly equates to 16% of the GDP [1, 2]. The total expenditure is increasing at an average rate of almost eight percent annually [2]. Contributing to this inflation are continued advances in technology which increases the need of healthcare specialists that have an associated fee-for-service (FFS) charge [3, 4]. The FFS is the service charge component to a visit, test or procedure. For example, when new imaging technology is introduced for diagnostics, the radiologists need the advanced training to interpret these results. When a charge is posted to a patient's account, it consists of supplies or room charges utilized, combined with the service fee rendered by the clinician. The FFS is a major contributor to the national healthcare inflation increase of 8% annually [2]. To deal with these increased expenditures, large Public Health Organizations are beginning to restructure the traditional healthcare service model. The current trend is implementing an Electronic Medical Record to increase productivity, decrease potential errors, and integrate national compliance standards.

Electronic Medical Record (EMR) software has long been forecast as a solution for housing all patient information in one digital repository that is accessible to any clinician independent of their location in the organization [5-7]. Large EMR vendors that develop these systems will tightly couple their application with the traditional physician centric healthcare model. In this model, the physicians make all the high level decisions, while other clinical staff provides support or have ancillary roles. The Emergency Department and Trauma Teams are the classic examples that still operate under this approach, in part because of critical decisions that require an Attending or Senior Resident to provide acute care to the patient. Today, this physician-centric model is the exception and not the rule in large healthcare organizations [8, 9]. Instead, healthcare is far more decentralized with many possible actors, including social workers, physician assistants, medical students, physical therapists and nurse practitioners taking the lead in providing a service, especially for chronic disease management. The services rendered by these providers continue to change as national, state, and departmental policies shift within healthcare organizations. Therefore, a loosely coupled model based approach to EMR design would better suit the changing nature of user requirements and needs.

This paper focuses on a failed attempt to upgrade a proprietary EMR system within the San Francisco Department of Public Health (SFDPH). This healthcare organization is a typical example of an institution that employs an array of professions who provide a variety of services. Often these services are rendered as part of a team managing patient care [10, 11]. As a result, the processes of a DPH are diverse and require the flexibility to change which provider plays the central role in decision making depending on what service is rendered [12]. This characteristic, one that is increasingly prevalent not only within a DPH, but smaller healthcare facilities across the U.S., is paramount in choosing an EMR and adjusting to the future role of healthcare as a service. Accordingly, recent efforts to upgrade the proprietary EMR within SFDPH failed. However, it was not budget constraints or technological barriers that caused this failure.

The upgrade was abandoned after the clinicians finally understood the EMR application could not adapt to their various clinical needs.

The EMR upgrade proposed to SFDPH comprised of a closed client-server networked architecture. This resulted in a tightly coupled application design with the assumptions built into the business logic tier. A much better solution is to modularize the design and focus on interface integration [6]. Service Oriented Architecture (SOA), along with the new Health Level Seven version 3 transaction standards provides a loosely coupled model perfectly suited for changing healthcare environments. Ultimately, the lack of flexibility in the EMR software was insufficient to deal with the variety of services provided at SFGH. This movement towards a decentralized approach to providing healthcare is a solution to the increasing FFS. These difficulties led the DPH to abandon the upgrade.

Business Case for an EMR Upgrade:

Beginning in late 2003, the San Francisco Department of Public Health began working to upgrade the existing EMR that was originally implemented in 1993. The current EMR is only a partial system as it tracks basic patient demographics, patient visits and all necessary information needed to support billing and revenue applications at SFGH. There are still many ancillary systems that contain information outside the EMR, and the paper chart continues to be the single repository of all the information. The upgrade would attempt to incorporate all the entities of SFDPH which include: County Jails, Laguna Honda Hospital (a long term care facility), Community Clinics and San Francisco General Hospital.

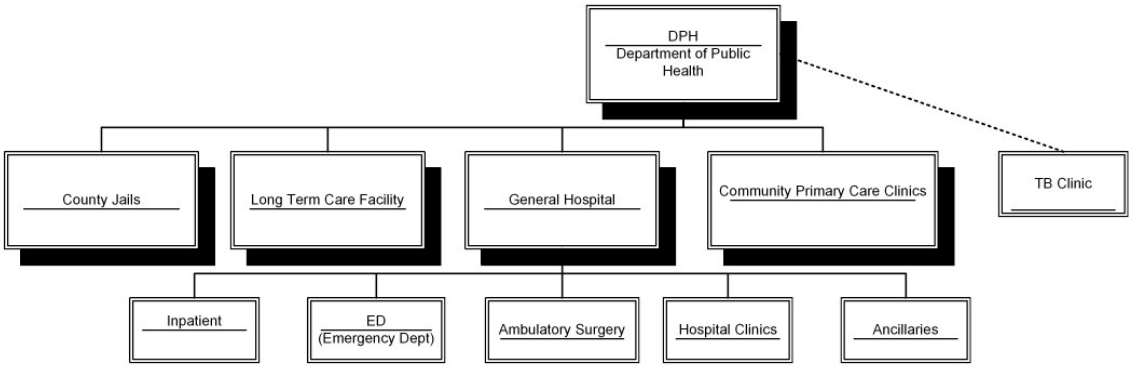

Figure 1: Top level organizational structure of the Department of Public Health

There are many benefits to upgrading the system that have been well documented in healthcare information literature and are as follows:

- Upgrading the entire department can ease the management and distribution of medical records throughout the organization [12]. Currently, the medical records department at SFGH spends countless hours and money pulling charts and sending them to the appropriate clinics. Switching to an EMR covering the

organization would not only be cost effective, it would eliminate the problem of charts being required in two places at once.

- Increasing productivity of the clinicians by providing a dashboard environment. After logging into the system, they view reminder screens, patient appointment lists, and the overall health history of a selected individual. With a partial implementation, using the primary care clinic as an example, the patient appointment lists are printed and posted on bulletin boards. Charts for all the visits are pulled and brought down from medical records, where administrative staff make sure they are delivered to the appropriate rooms. Labs and drug prescriptions can be viewed in the EMR while the clinician visits with the patient. However, all clinical notes, vitals, radiology and post-op reports are only in the paper charts.

- Upgrading to a department wide EMR could also decrease the potential for oversights and risk [13]. Lab values outside of normal range could be relayed to clinicians on their electronic dashboard, email, or even sent directly to pagers should they be excessively abnormal. This would reduce the economic impact of litigation if the warning systems are implemented and heeded effectively.

- Integrating drug suggestions that are dependent on cost and insurance carried by the patient at the time of visit could bring additional savings. In some studies, this reduced drug expenditures up to 34% as a result of basic medication decision support [14]. The insurance coverage for the patient population at SFGH changes frequently. Clinicians are often unaware of their patient's current coverage and the prices of specific drugs under a plan. This information would all be contained in the new EMR

- According to studies at hospitals, overall savings over five years after implementation can average $86,400 to $115,000 per provider [7, 14]. Of this amount, savings in drug expenditures made up the largest proportion of the benefits (33% of the total). While decreased billing errors and improvements in charge capture were a close second (30% of the total) [14]. With only six percent of individuals receiving treatment at SFGH having personal health insurance (independent of Medicare and Medicaid), this is a huge incentive for the city. This would decrease financial pressure on the city of San Francisco by curbing a portion of the current 100 million dollars in subsidies of the 487 million dollar hospital budget.

These alluring benefits of a successful EMR implementation can cloud judgment and cause decision makers to overlook potential failures. When SFDPH entered the agreement for the upgrade it was a continuation of the current terms without increasing the budget. For a public organization that depends on city subsidies for financial stability, this is a great opportunity for integrating the organization under one EMR without fighting a financial battle. In the following years spent working on the implementation, two major reasons were identified that eventually led to discontinuation.

The business logic incorporated within the EMR application layer didn't have the modularity to adapt to changing workflow requirements [15]. These assumptions were not consistent with the diverse needs of a large service organization. Second, there is the need for interface development with the isolated systems necessary for specific services (pharmacy, laboratory, radiology, imaging, etc). Instead of the EMR focusing on one portal for healthcare delivery, the process should first deal with a standardized enterprise interface and repository. This will make the integration of multiple front-end solutions easier in the long run.

Changing Workflow Requirements:

When work began on the EMR upgrade, the timeline was fairly ambitious. Within three years, all organizational entities would be live on the new system. The first tasks consisted of modeling the physical and conceptual views of the enterprise organization [16]. The emphasis was placed on defining the physical structure of the organization and modeling the processes that occur within the existing system architecture. The physical and conceptual model of SFGH follows the typical healthcare layout.

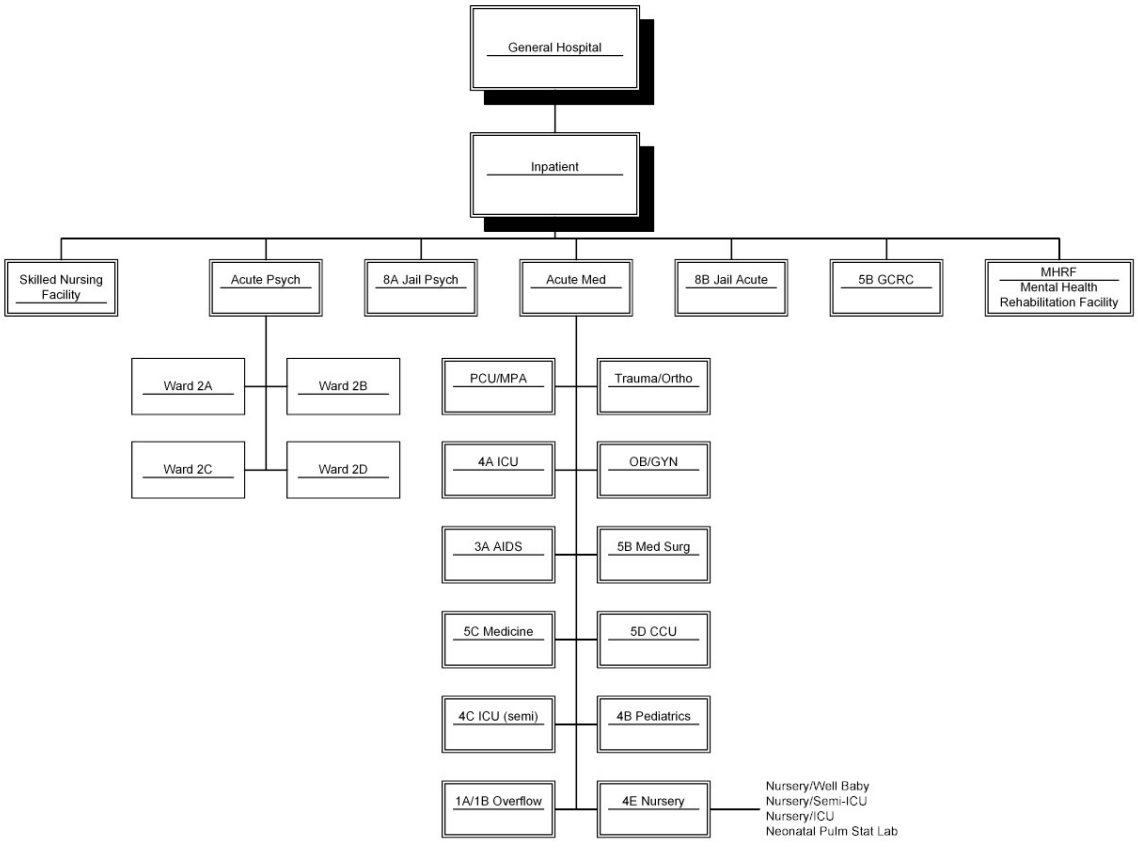

Figure 2: Detailed structure of the inpatient unit of the General Hospital.

The application layer of the new EMR system would elegantly handle the typical care patterns of the inpatient or surgical wards.

In a typical surgical setting at San Francisco General Hospital, there are teams of physicians that are responsible for patient care. An attending will be in charge of several surgical teams that consist of fellows, residents and interns. This is the traditional hierarchical structure of a teaching institution. For scheduled surgery, the administrative clerks check-in a patient and assist them to a waiting room. Nurses will take the vitals and record notes in the chart. They will then run through the pre-operative checklist and get the patient ready for surgery. The Anesthesiologist will begin the process of anesthetizing the patient and maintaining proper cardiac and respiratory functions throughout surgery. All of these tasks revolve around the physician providing service for the patient, with the nurse in charge of specific maintenance functions throughout the process. The nurses will record vitals, change IVs, prepare equipment and surgical tools, give injections, etc. The EMR upgrade at SFGH provides a dashboard interface for physicians and nurses. The physicians are able to enter surgical notes, view their patient lists, sign orders, write orders and all other functions expected of an MD. The nurse dashboard shows a limited view of the patient list. Allowing for entry of specific notes, vitals, and giving a work list depending on what orders are placed by the physicians.

The EMR upgrade is a perfect solution to the above scenario. With an organization as large as SFDPH, there are many unique services that operate with varying workflows. The healthcare services in the County Jails certainly don't follow the same physical models of a typical hospital setting, although some basic conceptual processes might remain the same.

> "Large organizations exhibit further complexities related to scale, numbers of distinct roles and processes, and the richness and inter-relatedness of information in the organization. Information exchange practices and systems are rooted in local work processes as well as wider patterns of co-ordination and communication [12]."

The vendor designed the upgrade using the classic three-tier architecture, which tightly coupled the application layer to the data. Instead of focusing the efforts on the similar goals and processes each entity retains in delivering healthcare, the application layer was developed using the hierarchical model of healthcare delivery. This incorporated the structure into the system. For example, in an inpatient setting there are rooms with a fixed number of beds assigned to patients. In the various County jails, there is no fixed number of people in a cell. This location dependency can fluctuate, thus changing the organizational model. Adding to this problem is the knowledge gap between the practitioner's understanding of the EMR, and the vendor's knowledge of the organization [17, 18]. The project can get to an advanced stage of development before these gaps are understood and addressed.

A better approach to modeling for SFDPH would be the focus on the standardization of business processes by identifying patterns [16]. The process standardization and employing XML would create a modular transactional layer that provides loose coupling to the application layer [19]. For example, both inpatient wards and the jails deliver medications to patients. The organizational models are unique for

each entity, one has a fixed number of beds while the other is variable, but the transactional information required for this service is the same. There are numerous processes that remain consistent across the organization and by standardizing these in a transactional model will make a variety of specific application interfaces much easier to implement. This leads into analyzing the current silos of information and interface messaging between these systems.

Non-Standardized Messaging and Integration Considerations:

The majority of information contained in an EMR is generated from external systems that are vertical silos (radiology, laboratory, pharmacy, PACS, etc). Therefore, building crosswalks and interfaces to store this information in an EMR can require the majority of time during implementation [6]. San Francisco General Hospital already operates on the most widely used transactional language standards of HL7 for clinical messaging, and DICOM for imaging. These standards provide bridges to the many islands of electronic patient data so that it can inexpensively be combined into an electronic medical record [6, 17]. The fact that the ancillary systems and the EMR can interpret HL7 should make conversion straightforward. The dilemma comes from the structural variation in HL7 version 2.x, which is the current national standard. The messages relayed are pipe delimited files that don't have associated metadata. Each vendor or institution has a different understanding of the specifications and information models. This leads to variation in the messaging that requires an additional layer for interpretation. Many institutions only implement a subset of the HL7 events [19]. The ability for adaptation and partial implementation eliminates the interoperability advantages of having a standard.

The current HL7 standard makes interoperability very difficult especially when communicating with vendors outside the organization. There is a considerable amount of reconciliation with metadata to describe the encoded messages. Also, when new ancillary systems are incorporated and messaging is required, mapping the expected fields is a time consuming process. The upgrade at SFDPH was focused on using the current HL7 standard and did not examine the possibility of adopting a component based design with the new HL7 version 3 and XML. Investing the time and money would enable the flexibility required by all the entities to serve their populations.

Modeling towards the Future (HL7 Version 3 and SOA)

Looking toward the future, SFDPH should be focused on creating a data layer that incorporates HL7 version 3 and XML. This is the latest version proposed by Health Level 7 and it has been in development for ten years. The standard incorporates seven different models that comprise the Hierarchical Message Description (HMD).

Information Model Mapping							Message Elements				
Object View		Object Views and Attributes		Attrib			Segment				egme
Nesting	Relationship	Name	Cardinality/ Rep Allowed?	Optional?	Data Type	Row Number	Nesting	Structure	Segment Slot Type / Tag Value	Shared Type?	Slot Note
1	*root*	Patient_encounter	1			1	1		ENC		1
						9	1	Choice			
						10		Tag	N		2
2	*specialization*	*none*				11					
						12		Tag	I		2
2	*specialization*	Inpatient_encounter	1			13	2		IPE		1
3	is_preceded_by	Patient_admission	1			16	2		PADM		2
						24		End Choice			
2	involves	Patient	1			25	1		PTP		3
3	is_a_role_of	Person [Pt]	1			32					
	generalize	Stakeholder				42					
	is_assigned	Stakeholder_identifier				44					
3	has_a_primary_ provider	Individual_HC_provider [Prim care phys]	0,1			46	1		PCP		4
4	is_a_role_of	Person [Prim care phys]	1			47					
						53	1	List	ListPTBA		5
3	has	Patient_billing_account	0,M			54	2		PTBA		1

Figure 3: Hierarchical Message Description Information Elements. One instance demonstrating the patient encounters hierarchy. **Taken from:** V3 Education: Building the HMD; January 25th, 1999. **http://www.hl7.org**

These models define the hierarchy of the message and when triggered is populated with enterprise specific information. This hierarchical message description represents a specific patient encounter instance, although every possible healthcare transaction is incorporated into the overall structure. Enterprise specific information is mapped and sent encoded as an XML instance. The messages can be reverse engineered and the data pulled into the receiving system.

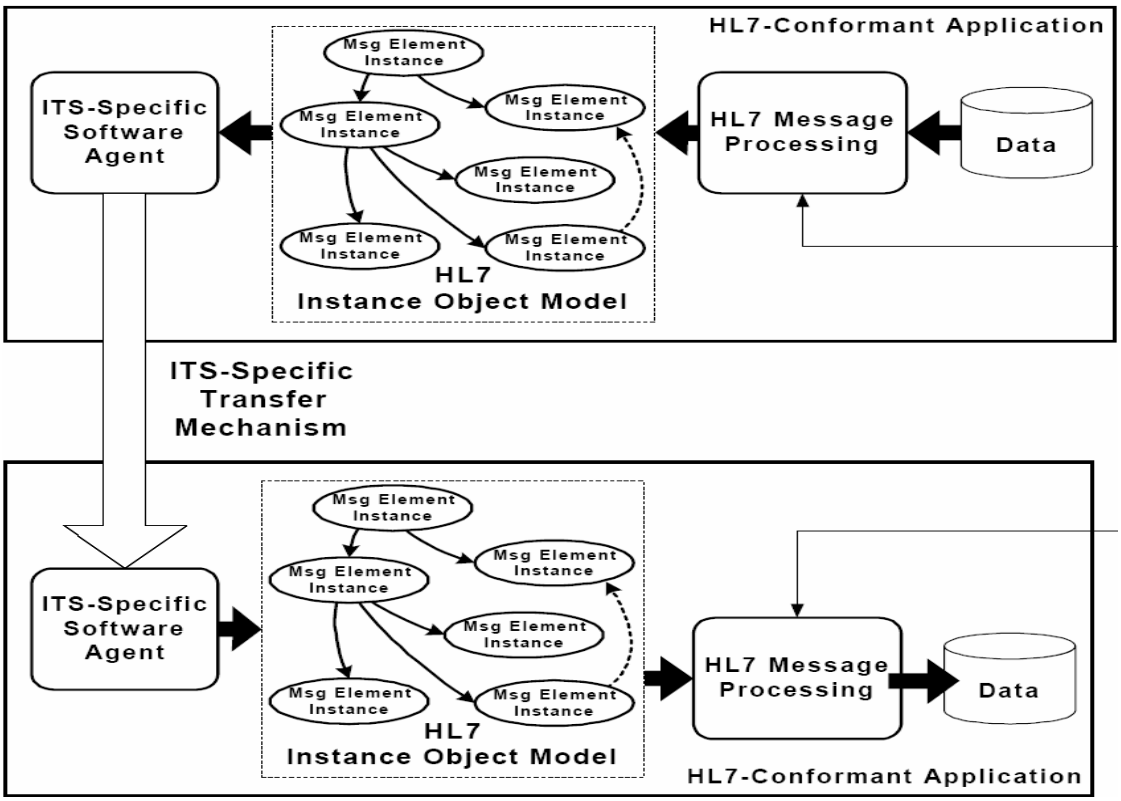

Figure 4: Message Element Type and Instance Object Models. The arrow pointing into the HL7 Message processing step is the HMD represented in Figure 3. **Taken from:** HL7 Version 3-Message Element Type Language; January 26th, 1999. **http://www.hl7.org**

While the information inside the HMD might be specific to the organization, the model remains constant and can be interpreted by outside sources without any explanation. The advantage of this messaging is the loose coupling provided by XML and platform independence. Normally, a major disadvantage to implementing XML messaging is the receiving end does not have the ability to interpret the conceptual design [16]. The benefit of standardizing the process is that the schema (HMD) is available to both parties.

Integrating a web enabled standard is a touchy subject because of security concerns and the potential for an increase in market competition. The advantage EMR vendor's currently maintain over the healthcare industry is due to large switching costs [20]. It is expensive for healthcare organizations to switch vendors, because they have expert knowledge of the complex system architecture. Should HL7 version 3 reduce these switching costs, the vendors and consulting firms might need to change strategies to retain customers. The advantage would squarely fall on SFDPH or any large healthcare organization. The standard produces an increase of market competition of products that will serve many different organizational needs. Instead of having one EMR to serve all functions, SFDPH could easily integrate many different application components. Also, there are many XML enabled tools for rapid application development.

Conclusion:

A successful implementation of an EMR is an alluring proposition to many healthcare organizations. There is the potential for economic and compliance improvements, while reducing common medical errors with an EMR that spans the needs of an organization. The companies that are designing these systems make certain assumptions about the services provided by primary care centers, clinics, hospitals and public health departments. When selecting an EMR, these organizations need to thoroughly investigate the product to insure it can adapt to the changing needs of the services they provide. The clinicians and information management staff should have a clear understanding of all the workflow processes that happen within the organization and spend the time analyzing the system to guarantee the appropriate interaction for all the players involved. Spending greater time investing on enterprise process modeling, coupled with HL7 version 3 and XML provides the necessary flexibility for incorporating a variation of healthcare services.

References:

1. Sidorov, J., *It Ain't Necessarily So: The Electronic Health Record And The Unlikely Prospect Of Reducing Health Care Costs.* Health Affairs, 2006. **25**(4): p. 1079-1085.
2. Smith, C., et al., *National Health Spending In 2004: Recent Slowdown Led By Prescription Drug Spending.* Health Affairs, 2006. **25**(1): p. 186-196.
3. Bodenheimer, T., *High and Rising Health Care Costs. Part 2: Technologic Innovation.* Ann Intern Med, 2005. **142**(11): p. 932-937.
4. Gelijns, A. and N. Rosenberg, *The dynamics of technological change in medicine.* Health Aff, 1994. **13**(3): p. 28-46.
5. Miller, R.H. and I. Sim, *Physicians'Use Of Electronic Medical Records: Barriers And Solutions.* < I> Health Affairs</I>, 2004. **23**(2): p. 116.
6. McDonald, C.J., *The Barriers to Electronic Medical Record Systems and How to Overcome Them.* Journal of the American Medical Informatics Association, 1997. **4**: p. 213-221.
7. Miller, R.H., et al., *The Value Of Electronic Health Records In Solo Or Small Group Practices.* Health Affairs, 2005. **24**(5): p. 1127-1137.
8. Hayes, G., *Can One Electronic Medical Record Suit all Clinical Disciplines.* Proceedings of PHCSG'97, 1997.
9. Heathfield, H.A., et al., *The PEN & PAD medical record model: development of a nursing record for hospital-based care of the elderly.* Methods Inf Med, 1994. **33**(5): p. 464-72.
10. Wagner, E.H., *The role of patient care teams in chronic disease management*. 2000, Br Med Assoc.
11. Wagner, E.H., et al., *Improving chronic illness care: translating evidence into action.* Health Aff, 2001. **20**(6): p. 64-78.

12. Hartswood, M., et al., *Making a Case in Medical Work: Implications for the Electronic Medical Record.* Computer Supported Cooperative Work (CSCW), 2003. **12**(3): p. 241-266.
13. Bates, D.W., et al., *Reducing the Frequency of Errors in Medicine Using Information Technology*. 2001, Am Med Inform Assoc.
14. Wang, S.J., et al., *A cost-benefit analysis of electronic medical records in primary care.* The American Journal of Medicine, 2003. **114**(5): p. 397-403.
15. Chu, S.C., *From component-based to service oriented software architecture for healthcare.* Enterprise networking and Computing in Healthcare Industry, 2005. HEALTHCOM 2005. Proceedings of 7th International Workshop on, 2005: p. 96-100.
16. Glushko, R.J. and T. McGrath, *Document engineering*. 2005: MIT Press.
17. Baron, R.J., et al., *Electronic Health Records: Just around the Corner? Or over the Cliff?* 2005.
18. Scott, J.T., et al., *Kaiser Permanente's experience of implementing an electronic medical record: a qualitative study*. 2005, BMJ Publishing Group Ltd.
19. Beyer, M., et al., *Towards a flexible, process-oriented IT architecture for an integrated healthcare network.* Proceedings of the 2004 ACM symposium on Applied computing, 2004: p. 264-271.
20. Shapiro, C. and H.R. Varian, *Information rules: a strategic guide to the network economy*. 1999: Harvard Business School Press.