

Best Practices in EMR Implementation: A Systematic Review

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Electronic medical records (EMRs) are continuing to evolve as a technology for use in medical practice. As experience with EMR implementations increases, new knowledge is gained on how to make their implementation more successful. Recently, several new conceptual frameworks described in the literature provide a richer understanding of what makes an EMR implementation successful. We attempt to integrate the various frameworks into an over-arching framework that is comprehensive, pragmatic and predictive of success.

Keywords

EHR implementation, EMR implementation, Success factors, physician implementation, CPOE implementation, frameworks.

1. Introduction

Computerization of medical practice is an on-going reality. Typically, most of the investment of implementation is borne up-front both in terms of finances, and in time and energy. With increasing fiscal restraint and a greater demand by all stakeholders for demonstrated value, it is important to ensure that EMR implementations are successful. Yet, in spite of over 3 decades of experience with EMR implementation, the penetration of the EMR is still less than 20% in the US and in Canada^[4]. The failure rates of EMR implementations are also consistently high at close to 50%^[5]. Existing EMR implementation frameworks do not explain all features experienced by implementers and have not helped to make EMR implementation any more successful. To provide more quantitative insight into EMR implementations, we are attempting to integrate multiple conceptual frameworks in an overarching, yet pragmatic framework to explain factors which lead to successful EMR implementation. This paper describes the first stage of the process: development of a framework, based on qualitative, iterative reading of the EMR implementation literature. EMR and EHR are here used interchangeably in this paper for the purposes of indicating an electronic record keeping system of health or medical data. We present preliminary results of our integrative approach, assessing over 50 EMR implementations in a variety of settings.

2. Objective

There are many expert opinion reports and qualitative studies on EMR implementations. The 'success factors' approach has been the most popular approach in the literature for describing implementation approaches, but has not been fully explanatory and predictive of success or failure. Recently, we have seen a few new approaches^[1-3] to explain implementation success. But none is fully satisfactory. We are attempting to find a framework that is explanatory and predictive of success by combining the various approaches discussed in the literature, and applying it against that literature following a rigorous systematic review process.

3. Methods

A search of the English language articles in MEDLINE, HealthStar, EMBASE and DARE was conducted from Jan 1, 1985 to May 31, 2006. We searched for key terms that included electronic medical records, its synonyms and the MeSH terms associated with them and the text word 'implementation'. We used PubMed's 'related articles' option. An iterative process of searching by finding a relevant article and then finding 'related articles' was used. Web sources for articles and papers were included by utilizing the Google® Search Engine technology. Bibliographies of relevant articles were combed. Published abstracts and presentations from computers in medicine meetings (AMIA, IMIA, HIMSS and TEPR) were examined. Personal communications with recognized leaders in the field were used to complete the search for relevant articles.

Inclusion criteria included 1) primary descriptions of EMR implementations or computerized physician order entry (CPOE) where it was part of a larger medical record implementation project and 2) implementations which involved physicians. Exclusion criteria included articles which were 1) purely technical in nature; 2) did not involve physicians; 3) dealt with patient acceptance only; 4) reviews or editorials that were mostly expert opinion and did not describe actual implementations; 5) intentions to implement, but not implementation experiences.

We developed our framework from reading 125 EHR implementation articles culled from a list of over 1500. Over 50 of these passed the inclusion/exclusion criteria and are included in the assessment framework development. We are in the process of validating our framework through careful analysis of the EHR implementation literature and statistical modelling of the framework. The statistical modelling will be described in a future article.

Here we describe our framework and its development. We developed the EHR implementation framework through an iterative process of reading primary implementation articles and identifying particular themes which we then mapped to one of the models identified below.

Several frameworks have been used to explain EHR diffusion and uptake in the literature, including Roger's diffusion of innovations model^[6], Collins' risk mitigation model^[3] and Ash et al's success factor matrix model^[1]. More recently, Berg et al have described the socio-technical model^[2] and Heeks describes a 'design-reality' gap model^[7]. Other frameworks which also appear to explain parts of the EHR diffusion and uptake include: Golden's strategic star model^[8], the people-process-technology model^[9] and Kotter's change model^[10] yet none of these fully explains many of the features of EHR implementations and EHR use found in the literature. We are seeking to develop and validate an integrative framework that utilizes different aspects of existing models and frameworks to explain EHR diffusion, implementation and use.

There are several features of EHR implementations that stand out in the literature: 1. EHR implementations play out over time. 2. Implementations involve people, processes and technology; 3. Implementations are prone to failure if there is poor governance and leadership; 4. Negotiation and dialogue between different stakeholders and between stakeholders and technology is quite prominent; 5. EHR implementations are dynamic processes which evolve as learning occurs and new problems and opportunities are discovered; 6. Technology reliability and usability play important roles.

4. Results

The framework we arrived at consists of success factor activities which are operational over 3 major phases of an EHR implementation: pre-implementation phase, implementation phase and post-implementation phase activities. [Figure 1](#) shows a pictorial representation of the framework.

This framework can be seen to be comprised of factors that aggregate in one of three phases of an EMR implementation. A factor can begin in one phase and end in another, but may spend most of its lifetime in a specific phase – it is to this phase that we allocated its primary relevance for the purposes of this framework. Some factors may depend on the execution of previous factors and those are drawn at the same level in the diagram. Factors are designated as primarily having to do with people, process, or technology issues and are color-coded as described in the legend.

Finally, some factors relate to other factors through some relationship – either one of dialogue and negotiation or one of learning and socialization. These relationships are shown as vertical arrows that either connect two related factors which are far from each other on the diagram (straight arrows) or connect several factors in the diagram which are close to each other (box with arrow heads).

Below we expand on the factors and their operational definitions and the background for them.

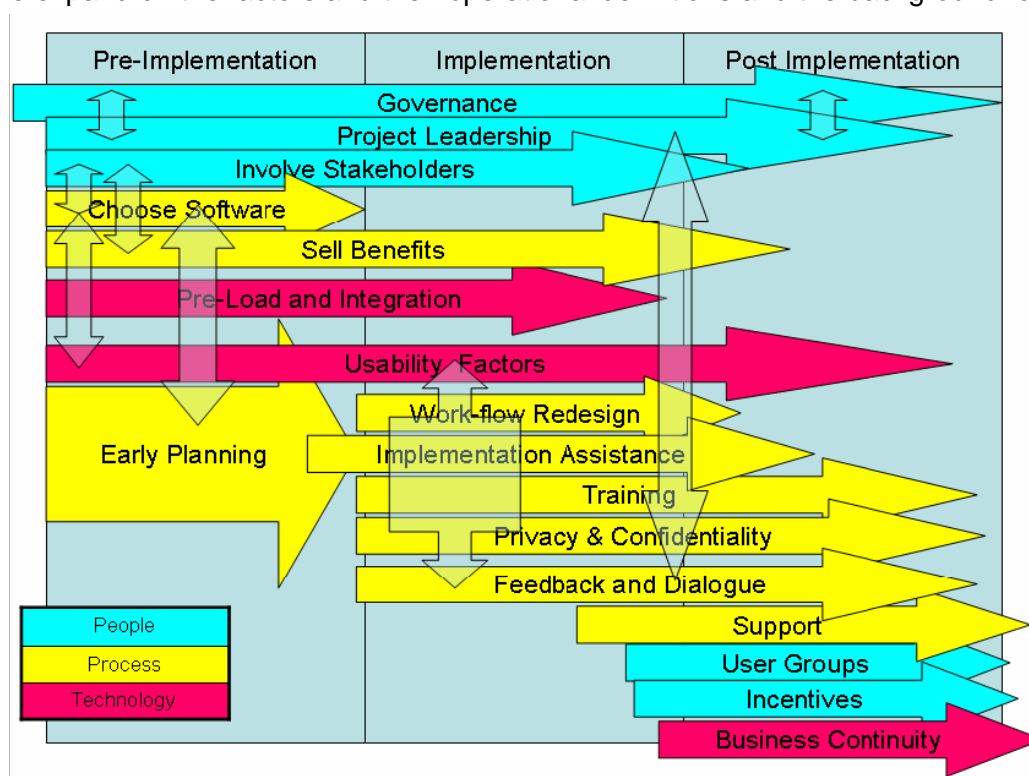


Figure 1 Phases and Tasks in EHR Implementation

4.1 Pre-implementation phase

In the pre-implementation phase are sown the seeds of success or failure. Once an EMR implementation begins, it is very difficult and expensive to return to this phase and start again.

4.1.1 Governance (People)

Whose vision is it and why are we doing it? The need for “governance” has frequently been cited as necessary for IT project success as well as for other forms of IT deployment and use in organizations ^[11-13]. Governance refers to senior management’s activities or substantive personal interventions in the management of the EMR implementation ^[11]. It is concerned with mission, vision and top management’s behaviours related to pre-implementation, implementation and post-implementation of the EMR.

With increasing health care complexity over time, health care organizations' missions/visions are focusing on increasing quality and clinical efficiency, and delivering services in an organized, efficient, and cost-effective manner. The EMR has the capability to facilitate workflow by reducing the time spent recording information and by improving data management. EMR also has the potential to be an excellent tool for monitoring health maintenance and doing reminders, providing accessibility of information, increasing the quality of information, improving clinical processes and clinical data capture, reducing medical errors, and increasing productivity^[14-15]. In this context, EMR plays a critical role to achieve to these missions and visions of the organization. Organizational support from the top is one of the most dominant factors associated with successful implementation of EMR^[16]. There are major software, hardware and professional role change decisions that organizations generally do not even consider when starting out. Without real commitment from the top, such stresses can easily doom an EMR effort^[17]. Commitment of top management helps to ensure adequate resource allocation^[16]; supports redesign effort and facilitates implementation steps^[18].

4.1.2 Project management leadership (People)

Who's in charge here? Project leadership encompasses two distinct roles: that of a project manager who has skills and experience in managing complex project implementations and that of a project champion who has organizational credibility with clinicians. At the outset of EMR implementation, it is important to define the role and responsibilities of the project champions and the project managers and select the right people for these important roles^[19]. According to much of the literature on project leadership, the destiny of the project champions and project managers is to be a bridge between top management and other stakeholders. The successful project manager should be able to plan, motivate, evaluate EMR, apply a participative management style, create an agreeable working climate, solve conflicts, negotiate with external contacts, coordinate and integrate and enhance internal communication^[20-21]. For large organizations, it is better to create an internal EMR committee rather than a single champion. The goals of forming an EMR committee are to gain enthusiasm throughout the working group that will spread to everyone and to set up realistic project management processes^[19].

4.1.3 Sell benefits, manage attitudes, assessment of preparedness and address barriers (Process)

How does it help me – I'm not ready? The important concerns for any practice considering the introduction of an EMR are its own internal readiness for this major change and change management^[17]. Prior to implementing and installing an EMR, the organization's state of readiness for the EMR must be analyzed. The organization must be prepared for change by identifying core values, understanding broader organizational context and stakeholder concerns, understanding end-user needs, creating a vision and compelling need for change, and being sensitive and responsive to organizational stress resulting from change^[10, 22]. In the mean time, demonstration of the benefits to the physicians, nurses and staff, addressing the obstacles and barriers, which prevent buy-in and developing solutions to these potential problems, and provision of quick wins can facilitate the success of change management.

4.1.4 Involve multiple stakeholders (People)

No wonder it doesn't work, did you ask me? Involving multiple stakeholders in meaningful ways means gaining their active participation and effective endorsement in the pre-implementation and implementation phases. User resistance to change and lower user acceptance by physicians and nurses are one of the main factors of failure^[23]. Many studies point out that implementations that fail fail because implementers make assumptions about user's requirements which are not shared by end-users and those implementations that enjoy broad

based stakeholder support are less risky and more likely to succeed^[24, 25]. An active role of multiple stakeholders during decision making in these phases can facilitate the end-user acceptance of the new system. Determining all stakeholder needs and requirements actively with any system redesign efforts is critical to success.

4.1.5 Choose software carefully (Process)

What kind of bells and whistles do we need anyway? Once the organization decides to move to an EMR, one of the most critical steps in the pre-implementation phase is choosing software carefully. Mission critical requirements for the clinical business of the organization must be considered in such choice. Thus, to increase the chance of success, management with technical advice and guidance, must choose software that most closely fits its requirements analysis, including the fact that EMR vendors use different hardware platforms, databases, and operating systems^[19]. Many factors come into play here including cost, user friendliness, information integration capacity, and vendor issues^[17]. A well defined selection process increases the success of this factor. Holbrook^[14] describes the main stages of systematic EMR evaluation process as: 1) survey of interest, barriers, desired functionality, willingness to pay; 2) development of detailed EMR evaluation form; 3) broad search for available EMR systems; 4) brief review of features of EMRs; 5) detailed vendor demonstration of EMR features in person; 6) site visits to EMR system user practice and vendor headquarters; 7) user evaluation of working copy of EMR using typical case scenarios; 8) finalist evaluations and negotiations.

4.1.6 Data pre-Load & integration (Technology)

How come I can't see my patient's lab results? Most advanced practices today ultimately want an EMR that can be effectively integrated with other information systems containing billing, lab reporting, scheduling, diagnostic imaging and referrals data. Integration provides access to existing data, and increases data accuracy and system efficiency. Another critical factor for successful implementation is putting together a strategy for entering the practice's old data. The practical benefit of entering past paper-based or electronic data is the ability to rapidly search and retrieve the actual data and it reduces the frequency and duration of transitions between paper and electronic records^[19].

The real value of an EMR system is seen when all users have access to data whenever and where they need it^[19]. In these terms, data pre-load and integration are inseparable points of EMR implementation. Total pre-load data and integration is becoming increasingly possible; however it often requires additional effort^[17]. Most significant problems are standardization, interoperability between different systems, and fits of workflows between EMR and other or legacy systems.

4.1.7 Technology usability factors (Technology)

How do I use this feature? Technology usability factors fall into two domains – hardware and software. Hardware usability speaks to structural issues such as placement of workstations, use of tablets and other form factors which fit into clinician workflows, speed of processing, etc. Software usability speaks not only to user interfaces, but also how software design supports clinical workflows and work processes.

One of the main problems faced in EMR systems is that they are challenging to use because of the multiplicity of screens, options, and navigational aids. Problems with EMR usability — especially for documenting progress notes — cause physicians to spend extra work time to learn effective ways to use the EMR. Steep learning curves can degrade already highly efficient and focused workflow. Designing easy-to-use software and providing "silver bullet" technologies such as voice recognition, tablet computers, or mobile computing can dramatically simplify EMR

usage^[25]. For the success of EMR systems implementations, technology usability is critical for overall system design including hardware and software, and for system selection at the outset.

These 7 factors start in the pre-implementation phase but affect next steps significantly. Here it is all about proper planning and anticipating and preventing problems in all three axes of people, process, and technology.

4.2 Implementation phase

In the Implementation Phase the work of EMR activation begins. This is the true test of an organization's preparations made in the Pre-implementation Phase, and of the overall match of these success factors to the nature of its EMR implementation.

4.2.1 Workflow and redesign

But will this EMR change what I do and waste my time? Computer use, interconnectivity, and access to medical information over the world web has dramatically changed the way physicians utilize technology in their practices^[27]. Recently, this has extended to increased interest and adoption by physicians of the EMR tool^[28]. Critical to successful implementation is the fit of staff and physician work flow to that of the EMR functional and usability design constrictions or flexibility^[29]. EMR is a tool to automate and facilitate the process of patient care^[27]. Understanding of the patient care process will be crucial in the successful transition to EMR^[27]. Smith and Newell define a clear set of basic components that define the clinical workflow^[27]. The fit of clinical workflow to EMR execution of the same task is critical and is improved iteratively during implementation. If the fit is poor enough, implementation can fail^[30].

4.2.2 Training

How do you expect me to use this if no one trained me and I have never used a computer before? Familiarization and training of primary users on the EMR should be both initial and on-going. Proper training is one of the key success factors for smooth transition to a paperless patient care system. Hands on training immediately prior to going live has been documented to be of great significance as the training is fresh in the minds of users^[29-31]. Vendors of EMR systems should also ensure that training is provided in the language of novice users. Management should also be aware that on-going training is just as important as initial training provided by the vendor^[30].

4.2.3 Implementation assistance

Hey, can I get some help here? Any successful implementation requires a strong vendor partnership^[31]. The vendor should be responsive and the system flexible enough to allow any system improvements and/or modifications that is identified by clinicians or primary users^[32]. Key to this is availability of vendors and human resources to assist in implementation. Such personnel should be available on-site initially^[33-35], and should be easily accessed throughout the implementation phase. Efforts are made to detect, solve and follow up on problems that arise during implementation. The help desk needs to provide rapid and efficient service, or clinical users will stop calling and find some other way to access and record data^[36]. Strong vendor contracts and relations are necessary to assure that adequate phone or on-site assistance are available. Alternatively, a person should be available, preferably within the practice, to handle hardware and software problems and communicate with the vendor^[17, 30, 36]. The presence of "Super-users"^[16, 28, 32, 36] or "Bridgers"^[37], who work within the practice, can identify and manage many problems because of additional training, special interest or broader experience.

They understand the environment of both the developer and the user^[7], and, because of ability and enthusiasm, serve to motivate others. Complementary changes need to be made to applications throughout the implementation phase for such tasks as custom templates, forms and shortcuts^[26]. Vendors usually only support technical problems. There needs to be a resource in the form of a “super-user”, physician champion or consultant to deal with changes necessary as form adapts to function.

4.2.4 Support

Who's going to help me after you're gone? EMR users require significant amounts of support, especially in the early phases after implementation. A myriad questions and issues arise – some trivial and some substantial, but all can lead to disenchantment and disillusionment if not handled appropriately^[24, 25, 26]. A problem as simple as a user forgetting their password and not being able to resolve it can quickly make the whole system unusable for several people. For example, a receptionist who forgets a password cannot schedule new patients, making it difficult for physicians to bring up patient charts in a timely manner, creating gridlock and mayhem in a very short time period.

4.2.5 Feedback and dialogue

Who do I talk to about this problem? Provision of a venue or forum for discussion of change and for negotiating changing roles (town-hall meetings, discussion sessions) is critical. Initial success in EMR implementation is often dependent on how the considerable change management stresses are dealt with^[37]. Helpful interventions or activities include but are not limited to the following:

1. Regular staff meetings^[36];
2. Opportunities for discussion and venting. This requires a thick skin on the part of the administrator, but vigorous criticism can have value for prospective change^[37];
3. Evaluation, monitoring and tracking of the progress of implementation. This is especially valuable if the EMR is rolled out in a modular fashion. In this way, the gap between design and reality can be recognized and minimized, thus reducing the extent and stress of change^[7, 36];
4. Systems to track issues and problems with a process in place to resolve them.

Recognizing that there are both technical and social aspects at work in EMR implementation, it must be seen that the technology and the organization transform each other during the process^[2]. Even with a well-planned implementation, the process can actually take on a life of its own, and a system for flexibility is essential^[38].

4.2.6 Privacy and confidentiality

Whose record is it anyway? EMR implementations must meet requirements for privacy and confidentiality. The legal concept of privacy is relative and shifts from time to time, as we have witnessed in airline security. There must be tradeoffs between confidentiality and access – one cannot maximize both^[39]. The ideal record system will provide appropriate and non-intrusive access while demonstrating robust data security. Physician and patient concerns regarding security must be addressed, especially for Web-based records. Patients have a more relaxed attitude toward security of their data, but there are still 24-40% of them who have data confidentiality concerns, particularly with Web-based applications^[40-41]. Particularly with improving standards, we should expect secure electronic transfer of information^[41]. EHR privacy and confidentiality should be at least equal to that of paper record systems^[42]. Minimizing risk of inappropriate data acquisition and transfer is critical to health data integrity and to its use. This

needs to be done through education concerning appropriateness of transmission, access control, system integrity, network security, clear data ownership, user profiles and audit trails ^[43].

Five major factors are critical to a successful EMR implementation and really represent exactly how the EMR will replace the old systems and enhance the development of new processes. It is all about the daily operations and delivery of the clinical business in this phase, and again the 3 components of people, process, and technology are present in this stage.

4.3 Post-Implementation phase

Following extensive planning in the pre-implementation phase and the flurry of activity that characterizes the implementation phase, the post implementation phase may seem less intensive in comparison. However, our review of the literature suggests that this phase is equally important for the overall success of an EMR implementation.

The elements that characterize this phase also encompass the people, process and technology axis. The same dynamic interaction of negotiation and dialogue in the earlier phases is also found in this stage of implementation. An important theme identified in a six year qualitative study of success factors in CPOE implementation was the “ongoing nature of implementation” ^[42]. Post implementation user involvement to foster value, training and support and system enhancements are activities that are vital to provide incentives for continued user involvement and buy-in and sustain the positive momentum of a previously well-planned and executed implementation.

4.3.1 Technical support and business continuity

The power went off – where do I find what medications my patient is on? As a first step to ensure that post-implementation activities can proceed, it is necessary, with vendor contractual agreements in place, to ensure that technical support for both newly installed hardware and software remain available and accessible in a timely manner ^[30]. There must also be a business continuity plan where there is provision for data protection and disaster recovery. Several authors describe situations where they were able to quickly restore data and get back to work after a significant disruption such as a flood or fire ^[31, 53].

4.3.2 User groups

I got all the training available, but there are still questions I have. Where do I get help? It is well established that only 20% of physicians are active adopters of innovation and new technology ^[45]. In fact, studies have shown that in the initial six month period following an EMR implementation, there is a decrease in the level of satisfaction ^[46]. The initial optimism which may not be grounded in reality for physicians, who have no previous experience using an EMR, is tempered by required tasks and issues that are seen as accessory to the provision of patient care. These include clinical recording which was perceived as taking more time ^[36], loss of autonomy ^[47] and a negative effect on patient rapport and privacy ^[46]. Only over time did physicians show an increased acceptance of the time and effort required to use an EMR ^[30]. We found that a structured format such as scheduled meetings or users groups led by EMR champions with a process to help users accept and grow in using the new technology in their work to be a critical factor in the post-implementation phase ^[46]. This interaction provides a forum for ongoing training and facilitates a cooperative dynamic where end users can solve technical problems, write templates, and teach each other about software features ^[29]. The set up of such “re-tooling teams” to address system refinements making just minor enhancements in system set up produced greater user satisfaction ^[27].

4.3.3 Incentives

If it's more work, then why should I keep using the system? Finally, in the post-implementation phase, there needs to be continuing incentives for users to continue using EMR. The identified benefits of an EMR that include improving patient safety^[49-51], increasing the efficiency of care^[50-52], faster access to clinical information at the point of care, and more efficient outcome assessment^[52] need to be demonstrated to all users. Varying studies document the potential economic impact of an EMR implementation^[53-55]. Although detailed cost benefit analyses may not be feasible, sustainable implementations feature at least some documentation of cost and time efficiencies^[56-57].

In summary, the operative features in the post implementation phase are extensions of those seen in the implementation phase as discussed under the implementation assistance, feedback and dialogue success factors. The emphasis is on sustainability through the continuation of strong vendor partnerships and quality improvement via user feedback processes, followed by added value with expansion of capabilities in patient care (e.g. - recall systems, e-prescribing, clinical decision support systems, chronic disease management, etc) that provide further incentives to promote full integration of the EMR into the health delivery system of an organization.

5. Conclusion

EMR implementations still face daunting odds. Close to 50% of implementations fail, causing significant financial losses, lost opportunities for improved patient care and significant anguish for implementers, clinicians and senior managers. Many authors have tried to dissect factors that lead to successful EMR implementations. However, most frameworks described in the literature don't explain all the factors that are observable in reading descriptions of primary implementations.

We report here the first attempt at integrating multiple frameworks from the IT, business and EMR implementation literatures to explain factors that may contribute to the success of EMR implementations.

We have synthesized an integrative, comprehensive, overarching framework for assessment of the EMR Implementation literature by combining the best components of existing frameworks, with a thorough qualitative analysis of the existing EMR literature. Factor development and framework design has been validated through an iterative process of design and testing against a qualitative systematic review of the literature.

Key to our current framework is the assignment of factors to a specific phase: pre-implementation, implementation, or post-implementation, and the comprehensive and integrative nature of them, including thematic threads of people, process, and technology-related factors that connects the factors. Additional frameworks that provide insight into experiences of implementers are integrated into an overarching framework that offers potential for even more insights into business and technology processes that lead to EMR success.

We are currently in the process of conducting a quantitative review of the literature. This review will be presented in a subsequent paper which will provide a more detailed statistical analysis of the framework and provide a statistical validation of the framework.

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