

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION
OF ELECTRONIC HEALTH RECORDS: RECONCILING
SYSTEMATIC AND HEURISTIC KNOWLEDGE

By

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CERTIFICATE OF APPROVAL

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Abstract

Implementation of an electronic health record (EHR) is a complex process which is not complete until physicians use the system in direct patient care.(Kaplan & Harris-Salamone, 2009; Pare, Sicotte, & Jacques, 2006) Failure to achieve physician adoption of a new EHR creates organizational risk, which can range in magnitude from failure to attain desired benefits (such as improving patient safety or gaining competitive market advantage) to threatening the financial viability of the institution.(Conn, 2007) Ensuring physician adoption of a new EHR is often under the direction of vendor consultants, institutional leadership, and third-party contractors. Approaches to adoption by consultants and contractors vary, as an individualized implementation approach is considered a marketing tool representing a competitive differential advantage.(Cerner Corporation, 2013; Dearborn Advisors; Dearborn Advisors, 2013) Institutional leadership may take varying approaches to adoption for many reasons such as biases acquired in previous experiences, lack of experience or training, or a desire to tailor an approach to local conditions. Although some variation in approach is expected due to differences in initial client state, unexplained variation in adoption practice might increase the possibility of inferior outcomes and increased cost. The use of a consistent, evidence-based approach may result in more consistent and more successful physician adoption of EHRs.(Stetler, McQueen, Demakis, & Mittman, 2008) Focusing on discovering items that could be expressed as specific activities or outcomes, we performed a thematic

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analysis of the physician adoption literature, then combined the resulting themes (and the resulting operational items) with the experience-derived opinions of a panel of experts.

The resulting set of items represents an operationally-focused list of critical success factors for physician adoption. By making these specific and detailed enough, they can be crafted into a framework or checklist. Such a tool could guide both inexperienced and experienced implementers to more consistent physician adoption of newly-implemented EHRs, while providing a springboard for further research on adoption best practices by helping to define the orthogonal dimensions of the adoption conceptual space.

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Critical Success Factors for Physician Adoption of Electronic Health Records:

Reconciling Systematic and Heuristic Knowledge

Introduction

Implementation of an electronic health records (EHR) is a complex, safety-critical project.(Institute of Medicine, 2012) In 2014, rapid uptake of these systems is currently being fueled by the Health Information Technology for Economic and Clinical Health (HITECH) Act, which financially rewards hospitals and doctors for specific uses of an EHR and will penalize non-use by 2015.(Wikipedia.org) However, in spite of years of both research and practical experience, implementations of electronic health records still often fail to achieve project goals.(Conn, 2007) End user resistance to an EHR may result in under-utilization at best, and stalled implementation or even deinstallation at worst. Failed implementations are costly, as installation of a modern EHR (including order entry, provider documentation, and business process modification) at an enterprise or multi-institutional scale can easily amount to hundreds of millions of dollars. (Moukheiber, 2013) At this level of institutional investment, an implementation failure creates organizational risk by diverting capital, operating funds and human resources from productive use (Moukheiber, 2013; Rosenthal, 2002), and by weakening the organization's position in an increasingly competitive health services marketplace.

The term "adoption" implies more than simple use of an EHR. The Merriam Webster online dictionary defines the verb "adopt" as: "To take by choice into a relationship" or

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“to take up and practice or use.”¹ A continuum of possible behaviors, therefore, from simple use to higher levels of engagement, could be referred to as “adoption.” In technology, the term “adoption” commonly refers to the uptake of a new technology by individuals and organizations, as discussed in Rogers’ Diffusion of Innovations theory. (Rogers, 2010) In the context of electronic health records, physician adoption implies regular and sustained use over an extended period of time.

While the technical aspects of EHR implementation are complex and require skillful execution for success, the desired benefits of system implementation such as improving operational efficiency and care outcomes can not be fully achieved until there is adoption of the system by physicians and other providers. The mere presence of an EHR does not imply that providers will use it. (Williams, 1992) There can be EHR implementation (albeit unsuccessful) without end user adoption, but there can be no adoption without system implementation. Therefore, implementation is not adoption, and to confuse these ideas is to risk implementation failure. Since physicians ultimately direct patient care, physician adoption is necessary for the safe and beneficial use of electronic health records. If physician adoption is the desired outcome of an implementation, the implementation must be shaped in a way that promotes the desired outcomes (adoption, patient safety, etc.).

Currently, implementation practices in the field are not standardized. Over time, vendors and implementation consultants have developed differing frameworks and

¹ Merriam Webster Online Dictionary; <http://www.merriam-webster.com/dictionary/adopting?show=0&t=1354931622>, accessed 2/4/2014

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practical experiential approaches to foster physician adoption.(Ash, Stavri, & Kuperman, 2003; Cerner Corporation, 2013; Dearborn Advisors; Dearborn Advisors, 2013)

Alternatively, vendors and consultants may focus on the technical aspects of implementation, leaving physician adoption largely to institutional leadership, who may be inexperienced in this area. Small hospitals, especially those with predominantly private practice medical staff, may not have the resources and expertise to ensure the successful adoption of an EHR. Consequently, variation in adoption practices is frequent. Since it is unlikely that divergent approaches to the same problem would all be equally valid, this variation in approach suggests that some process steps may be more strongly correlated with (and therefore more critical to) project success than others. One of the central ideas of modern process improvement methodologies such as Lean and Six Sigma is that reduction of unexplained process variance, resulting in better control over process, will improve quality and reduce waste. Therefore, reduction of unexplained variance may improve the quality and consistency of adoption results, minimizing implementation risk and maximizing organizational benefit.

There is a currently a rich literature that provides guidance to those who would facilitate adoption (see Appendix A). Although there are practical recommendations to be found, practitioners who work to ensure that implementations will facilitate physician adoption may find some limitations to the application of this valuable work. Keshavjee even takes the extreme position, with which few would agree, that the existing literature is not useful in real-world implementation.(Keshavjee, 2006) Although much is known about critical success factors for adoption, the knowledge is presented using varying

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conceptual frameworks and varying vocabularies. When reading this literature, it can be quite unclear if or how these frameworks map to each other, and how they relate to the actual process of implementing for adoption. For example, key terms in this area are not standardized. Just as epistemologists have yet to agree on what constitutes “knowledge,” adoption researchers have yet to agree on precisely what constitutes “adoption,” and more specifically how to measure it.(Donabedian, 1980; Harshberger et al., 2011; Leonard & Sittig, 2007; Stefan, Ali, Ivo, Jan, & Helmut, 2011) Similarly, while the conceptual basis for technology adoption is reasonably well-defined and accepted, mapping these concepts to operational constructs such as committee formation or training planning is a poorly-characterized leap. Finally, current literature recommendations for critical adoption success factors tend to be high-level and strategic, rather than specific and operational. In terms of potential adoption process standardization, the critical success factors should be as granular and operational as possible.

Despite the great value of this systematic academic knowledge, there is still a largely unpublished body of practical knowledge held by those who are tasked with implementation adoption, which has been acquired from multiple implementations through skinned knuckles, missteps, occasional open-mouthed terror, and other forms of experiential learning. This experience generates a heuristic, rule-based knowledge that, although anecdotal, contains its own operationally-focused wisdom. Synthesizing these two approaches by providing an opportunity for experienced implementers to assess relevant, systematically-acquired academic knowledge through the lens of practical experience, should extend the knowledge base by identifying a concise, specific,

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operationally-useful set of critical success factors that will consistently and reliably promote physician adoption.

The research question(s) therefore is:

- can we develop a set of critical success factors for physician adoption of electronic health records that are theoretically grounded, empirically informed, and operationally specific enough to facilitate reduction of variance in EHR implementations?
- can we operationalize these CSFs so that they can be integrated into the process of technical EHR implementation?

Materials and Methods

The study was performed in two major phases. The first phase was to perform a thematic analysis of the physician adoption literature, resulting in a set of themes and codes related to critical success factors for physician adoption of electronic health records. The second phase of the study was to assemble a panel of individuals expert at managing physician adoption during EHR implementations, using their expertise and input to filter the literature-sourced list and to create a final list of factors critical for successful physician adoption.

Thematic Analysis

The thematic analysis focused on a specific research question: what does the literature tell us are the critical success factors during implementation that facilitate physician adoption of electronic health records? The analysis sought granular insights, recommendations, advice and observations that were specific and detailed and could be

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stated or restated as an activity or task. However, higher-level, more generalized items that could guide the development of a framework were also captured.

General information and advice about performing thematic analysis was reviewed. Sources included OHSU course materials, and materials found on the internet, primarily from academic institutional websites offering practical advice about performing thematic analysis.(Attride-Stirling, 2001; Braun & Clarke, 2006; Pyett, 2003; Ryan & Bernard, 2003; Subvista.com; The University of Auckland; Wikipedia.org) The use of CAQDAS software was considered. Available software was identified, and the advantages and disadvantages of this approach were weighed.(Lewins & Silver, 2009) It was finally determined that the scope of the current project did not warrant the startup cost of acquiring, installing, and learning the software so a manual approach was used.

A log was kept to capture a record of both the activities and of the thought processes during the thematic analysis. Doing this ensured completeness and avoided duplication of effort in a time-consuming process. By maintaining a journal while working, a trail of intellectual breadcrumbs was created, helping to keep track of where this author had been and was headed, without getting lost along the way. This log was kept in the hierarchical outlining application OmniOutliner (initially version 3, then later version 4)² on an Apple computer, and on the iPad version of the same application, which were kept in continual, automatic synchronization utilizing a cloud service.³

² Omni Software Group, <https://www.omnigroup.com/omnioutliner/>

³ OmniPresence, <https://www.omnigroup.com/omnipresence/>

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Although non-automated, the thematic analysis workflow was entirely computer-based. An Apple laptop computer utilizing the current version (10.8 initially, then 10.9) of the Mac OS X operating system and an Apple iPad 3 utilizing iOS7 were the computing devices used. Articles were imported into the laptop (OS X) version of the bibliographic database application Bookends⁴ or on the iPad version of the same software. The two versions were manually synchronized after each work session. Any articles that had been downloaded in non-PDF formats were converted to searchable PDFs on the laptop, by exporting to DevonThink Pro Office⁵, and then re-importing into Bookends. Searches for articles were done primarily on the laptop, but the actual reading and review of articles was almost entirely performed on the iPad due to the device's more comfortable reading format and superior annotation tools. Articles were transferred from the Bookends iPad application to the iPad application PDFExpert (initially version 4, then version 5)⁶, and then transferred back to the Bookends iPad application with their complete annotations. An annotation summary for each article was exported as an email attachment, and then copied and pasted into an OmniOutliner document on the laptop. This allowed text fragments, their associated codes, and page locations to be kept together in an easily searchable format. Maintaining synchronization between the desktop and iPad versions of Bookends maintained the laptop's database as the project's single source of truth, as well as affording the superior data backup and manipulation tools of the laptop computer.

⁴ Sonny Software, <http://www.sonnysoftware.com/>

⁵ Devon Technologies, <http://www.devontechnologies.com/products/devonthink/devonthink-pro-office.html>

⁶ Readdle, <http://readdle.com/products/pdfexpert5/>

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After the initial screening, the articles to be included in the analysis were labeled “Included” utilizing the article labeling functionality in Bookends.

Multiple searches for articles were performed, refining the search terms iteratively to maximize the number of relevant articles returned. Initial search terms included: EHR (including variants such as “electronic health records” and “electronic medical records”), CPOE (including “provider order entry,” “physician order entry” implementation, success (including “success factors,” and “critical success factors”), adoption (and “physician adoption”), framework, evaluation, assessment, measurement, and formative. Search targets included PubMed Central, Cochrane Reviews, CINNAHL, Google scholar, and the author’s own informatics library. This resulted in 89 articles for review.

These eighty-nine articles were reviewed to determine which would be included in the thematic analysis. Selection criteria for the final set was that the article directly addressed specific factors that related to physician adoption during implementation, and that the advice or recommendations discussed or implied could ultimately be expressed in terms of an action or specific deliverable. In other words, the information could be expressed in a fashion that would be appropriate for development of a framework, checklist, or project plan. For example, although "establish good governance" is indeed a critical success factor found in multiple articles, when stated in this form it is not easily operationalized. We were seeking critical success factors that are readily operationalized. They are specific, tangible, and can generate a list of actionable tasks that can be localized to a specific setting. Once a dataset of articles was selected, the bibliographies of these

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articles were reviewed for additional candidate articles which had not been recovered on the initial search. These were retrieved and reviewed, yielding a very small number of additional relevant articles. The final set of articles forming the thematic analysis dataset numbered 16, shown in the accompanying Table 1.

Table 1: Thematic Analysis Dataset

Ash et al., 2003	Morton & Wiedenbeck, 2010
Berg, 2001	Palm et al., 2010
Castillo et al., 2010	Sanchez et al., 2005
Daigrepont & McGrath, 2011	Sheikh et al., 2011
Keshavjee, 2006	Silow-Carroll et al., 2012
Levick et al., 2005	Terry et al., 2008
MacKinnon & Wasserman, 2009	tnREC
Merrill, 2010	Upperman et al., 2005

Although the initial assumption was that only literature about inpatient implementation would be relevant, a review of ambulatory-focused articles showed that the critical success factors were not substantively different from those of inpatient adoption, varying in degree of importance rather than absolute differences. This is consistent with the previous findings of Ash.(Ash et al., 2003) Since the importance of any particular success factor will be expected to vary from one implementation to another due to differences in initial organizational state, articles about both inpatient and ambulatory venues were included.

Analysis of the thematic dataset was interpretive and iterative. The first reading was to get an overall sense for the concepts discussed and how these were being presented, in

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terms of context and language, by the various authors. A list of potential codes was created during this process and initial labeling of relevant text fragments began. The resulting list after this first pass included 132 initial codes. Subsequent readings expanded the initial code set, while differing codes describing the same concept were consolidated and renamed to better reflect the meaning of the text. The boundaries of the text fragments were refined to ensure that they expressed a single, complete idea and that the codes were consistently applied. Text fragments that, although important to the points being made in the article, were not relevant to the research questions were discarded. The result was a list of 819 codes. A final round of cleanup consolidated synonymous or closely related codes (determined by further inspection of the associated text fragments) and variations of the same root word. For example the codes “align”, “alignment”, and “aligned” would become a single code named “alignment.” After this refinement, the code list contained 515 items, shown in Appendix B.

This set of codes that had been maintained and refined in OmniOutliner was exported via an OPML file to mind-mapping software⁷, which allowed for easier non-destructive grouping and manipulation of the codes. Over multiple passes, the codes were grouped with other codes representing related concepts. This was done initially at the code level, with the next pass grouping related code groups into meta-groups, and so on with multiple passes until high-level themes began to emerge. The emerging themes were considered in relation to the code set until a minimal set of non-overlapping themes that completely covered the conceptual space was developed. After enumerating these themes,

⁷ iThoughtsX, <http://toketaware.com/ithoughtsx-main/>

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the last pass was to ensure that all of the meta-groups were grouped with appropriate related theme. A copy of the final thematic mind map can be found online⁸ in Freemind format (.mm).

Delphi

After obtaining IRB approval, an expert panel of 10 physician informaticists experienced in EHR implementation was assembled. A list of candidate physician experts known to have direct, hands-on experience in electronic health record implementation was created. The expert candidates were known to the author as current or former professional colleagues or as fellow members of AMDIS (Association of Medical Directors of Information Systems, <http://amdis.org/>). These individuals had participated actively in at least one enterprise or hospital EHR implementation that included CPOE, physician documentation, and clinical decision support. We attempted to diversify the panel by geography, system types (commercial, home-grown, EHR vendor), and by various implementation site characteristics (university, private, federal, large, and small).

A recruitment email had been prepared and approved by the IRB, providing details of what was being asked of the potential participants, and the expected time commitment if they chose to volunteer. Email addresses were obtained from openly available sources, such as email signatures, LinkedIn, and professional society contact lists.

Consent was obtained and documented through SurveyMonkey (www.surveymonkey.com). The recruitment email was delivered by SurveyMonkey. The

⁸ (<https://dl.dropboxusercontent.com/u/4514593/Adoption%20critical%20success%20factors.mm>)

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recruitment email included a link to a one-question survey. The “question” was in fact an IRB-approved information sheet. Potential subjects could indicate their availability and consent to participate by clicking "I agree". This allowed storing the subject consents separately from survey data within the SurveyMonkey project.

On a first round, the recruitment email was sent to 15 individuals. After assessing the initial response rate, an additional 22 emails were sent, for a total of 37 invitations for participation. 13 individuals agreed to participate in the study (35%). Two of these were excluded because they responded after the response cutoff date, for a corrected response rate of 30%. 22 individuals did not respond to the recruitment email. One individual responded by opting out of any further communication, and one individual could not be contacted because the email bounced. Of the 11 individuals who agreed to participate within the recruitment time period, 10 completed the first round survey (91%) and 8 completed the second round survey (80% of the first round participants).

Data was collected from the experts using a two-round Delphi approach. This approach allowed us to provide each participant with feedback from the entire group by including the aggregate opinions from Round 1 in the Round 2 survey. Aggregating the responses preserved the anonymity of each expert's individual responses. This allowed the experts to interact so that group opinion could converge on a consensus, without the influence of seniority, celebrity, political weight, forcefulness of personality, or any other group dynamics factor distorting the final results.

The Round 1 survey was constructed from a subset of the critical success factors derived from the thematic analysis. To avoid confusion about terminology that might

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hinder convergence of opinion, specific working definitions for “physician adoption” and for “critical success factors” were given to participants. Similarly, terms which might have specific connotations to participants were avoided in favor of more general terms. For example, a question regarding project management would refer to a “project management group” rather than to a “project management office” or a “project management committee” in an effort to keep the focus on the entity’s overall function rather than the specific structure or details of any particular instance of a project management group. At the end of the survey, a series of questions were included to validate the expertise of the experts and to assess their level of formal training. They were asked the number of EHR implementations that they had participated in, the variety of vendors systems which they had implemented, and their degree of formal training. The latter question was of interest, because formal training should imply familiarity with the implementation and adoption literature, which may bias the participants toward agreement with the literature-based CSFs.

Due to project timeline constraints, as well as a desire to be respectful of the expert panel members’ time, the first round survey questions focused primarily on the major thematic dataset themes and a subset of related codes. The subset of codes was selected by subjective determination of their relative importance in the dataset and by the perceived ability to express them in clear, relevant, actionable terms, without “reaching” beyond their stated or implied intent. Some were deliberately left more in the form of a goal because the specific tasks required to achieve the goal might be highly variable from

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one institution to the next. The CSFs were presented as a series of statements organized into topically-related lists. Participants were asked to consider each statement's importance for physician adoption: specifically, as a physician informaticist who is facilitating physician adoption in an institutional or multi-institutional implementation. From this context, they were asked to indicate their level of agreement with the survey statements on a 5 point Likert scale, ranging from "Strongly Disagree" to "Strongly Agree." Their level of agreement therefore would indicate the strength of the panelist's belief that a given statement has a significant impact on physician adoption. They were then given the opportunity to recommend items to be added to the lists, and to clarify or to expand on their responses. In order to limit the time required by participants to complete the survey, there was "compression" of the literature CSFs by combining related ideas, and favoring higher-level ideas over more granular and specific CSFs.

The second round survey was constructed using the answers from Round 1. Each question was constructed in the same fashion. The Round 1 question was restated and the average response and range of responses were noted along with any comments the panelists made. Each panelist was then reminded of his or her Round 1 response and given an opportunity to change that response. Finally, they were presented with the panel's newly suggested CSFs and asked to indicate their level of agreement. As in Round 1, the CSFs were presented as statements.

Surveys were delivered and responses recorded via an online survey tool. After evaluating online survey tools, Survey Monkey (www.surveymonkey.com) was chosen primarily because of its ability to maintain the confidentiality of responses, its ability to

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automatically email survey links to the experts and track their responses, and due to the shorter learning curve attributable to familiarity with the product.

Results

Thematic Analysis

There were several over-arching themes that touched on nearly every aspect of the implementation and adoption process. These were difficult to express in operational terms, and were more overall conditions rather than specific tasks. The foremost of these is that in order to secure physician adoption, physicians must be involved meaningfully in every step of the process that will affect their work, especially in the early stages of implementation. Physicians are the ultimate directors of patient care. Decisions which negatively impact the effectiveness or efficiency of physicians will eventually negatively impact the effectiveness and efficiency of patient care, leading to worsened patient outcomes. The thematic analysis revealed several key overarching implementation concepts that are not readily expressible in terms of specific operational tasks, but rather provide context and detail to many of the specific tasks derived. These concepts go to the core of the adoption process and are woven throughout. These key concepts include:

- Success/failure. Stakeholders will judge the success or failure of the implementation throughout the project and their determination will impact the likelihood of achieving physician adoption.
- Time. The sufficiency and management of time are critical for success, appearing directly and indirectly in numerous forms such as: stages or phases of implementation, physician productivity, adequacy and structure of the project

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timeline, budgeting time for activities such as training, whether to pay for physician time for training, design, and support, and using deadlines to keep project on track.

- Psychological ownership. Berg has pointed out the necessity of a psychological sense of ownership among physicians as a necessary precursor of successful adoption. Creating this state occurs via activities and opportunities to develop leadership attitudes throughout the implementation project.
- Perceived usefulness. Adoption is greatly aided, and often requires, that physicians see utility in the system in order to adopt it. (Vassilios, 2009) Achieving this aim requires physician involvement and good project decision-making throughout the project timeline, but especially in the design phase.
- Perceived ease of use. Considerations are similar to those of perceived usefulness. (Vassilios, 2009) Again, this must be addressed throughout the conceptualization, design, and implementation phases of the project and has a strong impact on the likelihood of physician adoption.

The dataset revealed that achieving physician adoption during the course of an implementation is a multifactorial process, which can be expressed in terms of critical success factors. The thematic analysis revealed nine major physician adoption critical success factor themes, each stated in terms of specific actionable outcomes, and each associated with its own cluster of codes and sub-codes. These are shown in their entirety in Appendix D, and summarized here. They are listed here roughly in the order in which they would be encountered during an implementation rather than in any presumed order

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of importance, as the experimental design did not attempt to assess the relative importance of any single CSF.

Theme 1: Determine the overall project vision, benefits to be attained (including strategic imperatives as well as current and anticipated external requirements), the specific goals for the project and how these will be measured. Development of a shared organizational vision was discussed by several authors as an important initial step toward physician adoption. This shared vision was not discussed as a static concept to be developed for potential motivational value and then set aside, but rather as a desired future state to be continually communicated and promoted, providing a constant navigational reference point when the implementation is blown off course by externalities or the organization becomes swamped by the daunting array of decisions and details to be decided, or the passage of time and the inevitable development of fatigue cause staff to forget why this project was begun in the first place. It is important that the vision truly be shared among stakeholders rather than imposed from without if it is to be able to withstand the stress of an implementation. From an operational standpoint, this shared organizational vision drives an outcome-focused process that defines desired benefits. The vision and desired benefits are expressed in terms of specific goals and the associated metrics for those goals. Ultimately, these metrics will guide and define the success of the implementation project.

Theme 2: Identify and cultivate physician and executive project leadership. The identification of key executive and clinical leadership at the outset of the project was another common and important theme for facilitating adoption found in the dataset.

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Physician leadership was noted as particularly important for physician adoption, but good executive leadership was critical as well. Although existing top executive and clinical leaders should be actively involved in the project, additional physician leaders should be identified among the medical staff to fill key operational roles (such as design, training, and maintenance) during and after implementation. Some or all may be emerging leaders who will need coaching and cultivating. Among the key leadership roles discussed in the dataset, a group of physician champions should be identified and developed early in the project. This group will guide many aspects of the project's clinical development, providing an important communication channel and a continuing source of support and encouragement for the medical staff. These executive and clinical leaders should share a number of important characteristics. They should be strong, senior leaders who are trusted by the organizational members, and particularly by the physician staff. They must be visible, honest and realistic, unwaveringly committed to the project's success, and viewed as able to overcome constraints and willing to follow through on commitments. Additionally, executive leadership should be members of top management and actively engaged in the project. It is critical for success that physician leaders should be seen as advocates for the medical staff. The dataset also discussed the role of consultants in the implementation and adoption process. Valued for their expertise and their ability to provide needed manpower, consultants can best foster physician adoption by playing supporting roles in implementation and leaving the organization, guidance, and decision-making in the hands of the organizational leaders.

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Theme 3: Establish effective project governance & communications. This theme encompasses three closely-related areas that could in fact be three sub-themes: governance, communications, and change management. They are rolled up here into a single theme, because in the dataset these ideas are tightly interwoven and overlapping. Planned and structured governance and communications were in fact the main vehicles for change management, and much was said about these areas.

Change management factors discussed included those necessary to develop a critical mass of organizational members who are willing and able to change the way they work. Operationally, an assessment of the organization's culture and ability to change was recommended, looking at patterns of influence (including social networks and key users), resistance, communication/feedback, group interactions likely to be affected by the upcoming change, and other potential barriers or opportunities. A strategy for creating and sustaining motivation should be explicitly decided after appropriate discussion, including the rationale behind the need for change, how to build and sustain enthusiasm for the project, and how to create and manage positive and negative incentives. Ideally, this would be a written plan developed with physician staff involvement.

Governance is about decision-making. A written governance plan determines who the stakeholders are and what the process for making decisions related to the EHR is. Stakeholders will be involved in decision-making or will need to be kept informed of decisions made. The requirements of patients must be at the center of the decision-making process at all times. Internal stakeholders must be engaged early and well-represented. The needs and requirements of external stakeholders such as regulatory

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agencies and community providers must be understood and acknowledged in the decision-making process.

The governance plan should also determine the structure and process of decision-making. Many impactful decisions will be made in what will likely feel like a short period of time, so the structure needs to be set in place as early as possible. The committees involved, whether altered existing or newly created, their charters, and their reporting relationships should be explicit. These committees are critical for stakeholder engagement, especially physician engagement, by ensuring local input and choice while simultaneously maintaining central control and management of the project. Likewise, committees serve as important forums for discussion, dialogue and negotiation, resolving conflicts and facilitating compromise and consensus, and promoting fairness and balance in the decision-making process. Modification of organizational bylaws, regulations, and policies is a critical success factor that is accomplished through the governance process. For example, among the numerous policies which must be written or re-written is a requirement that physicians must actually use the EHR as a condition of continued clinical privileging. Making this a request to the medical staff rather than a policy mandate sends the message that the implementation and its attendant disruption may actually not be necessary, inviting failure of physician adoption and of the implementation.

The governance plan should be a written document that addresses the functions of governance: ensuring accountability, promoting stakeholder involvement, managing

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stakeholder expectations and attitudes, monitoring progress, maintaining momentum, addressing barriers, allocating resources, and identifying and managing risks.

Lastly, communications planning is critical for physician adoption. The communications plan should be written and specify which messages are to be received by whom at what times and how they are to be received. The plan should be completed and set into motion early in the implementation process. The communication plan ensures that information critical for success is communicated in a timely manner to the correct people, and provides opportunities for feedback to central management, facilitating give-and-take in decision-making. Effective organizational communications sustain momentum by reminding organizational members of the shared vision and project benefits, while providing education, managing expectations, and lessening uncertainty through status updates.

Theme 4: Assemble a competent and experienced project management team with day-to-day control of the project. While the governance structure provides overall direction and control of the implementation, implementing an EHR is a large project for any institution, with daily oversight required for successful completion and maximal physician adoption. A project management team, led by a good project manager is critical for implementation and adoption success. This group is responsible for the planning and daily oversight of the implementation details, as well as periodic assessments which ensure that milestones are being met, that timely progress toward goals is occurring, and that project scope is being maintained. An experienced project manager is helpful because the planning process and framework are critical for success. A competent,

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professional approach to managing the project builds trust and confidence in users, particularly in physicians, thus fostering adoption. If the organization does not already have appropriately qualified individuals on staff, they should consider hiring or contracting these individuals. The project management team should be responsible for collecting performance data and conducting periodic assessments to ensure that the project remains on plan, on budget, and on track to achieve the stated goals and benefits. By their nature, these will be formative rather than summative assessments, but should be driven by a consistent set of measures defined at the beginning of the plan in order to yield internally consistent, actionable data. When the project inevitably deviates from the expected course, the project management team will ensure that appropriate corrective or adaptive actions are taken. An aspect of performance monitoring that is important for adoption is to monitor user (specifically in this case physician) satisfaction and attitudes. This data is useful for identifying and managing resistance and ensuring that physicians are receiving effective and timely messages through the communications plan.

Theme 5: Modify existing IT Infrastructure to support project goals and requirements. Because the full scope of IT infrastructure modification necessary may not be completely understood at the outset of the implementation project, it is important to begin work as early as possible. The adoption dataset noted a large number of IT factors that directly impact physician satisfaction and adoption. Some of the key items are noted here in this section.

- Interfaces to existing systems that will persist should be completed and tested prior to go-live. Physicians should be trained to access and use these systems as necessary.

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- A useful amount of historical patient data should be loaded into the system prior to go-live. The organization should decide how much data to load, balancing the cost (in dollars and labor-hours) of loading the information against the cost (in chart pulls, lost time, physician satisfaction, and potential care errors) of not loading information.
- Network access, both wired and wireless, of sufficient quality to support peak usage should be available at go-live in every location where it will be needed, including remote areas such as clinics and diagnostic or surgical centers. Internet access into the system should be stable and redundant. Wireless signal should be strong enough to support good end-user performance in all patient care and physician work areas. Slow or intermittent system access, especially in hosted or virtualized systems, will significantly impair physician adoption.
- Strategies such as single sign on applications, thin client workstations, or proximity badges should be considered to minimize the time physicians spend logging into the system. Hospital-based physicians in particular can spend a large amount of time logging in and out of multiple systems. This creates a risk for adoption, as well as a risk that physicians will develop insecure workarounds to minimize the problem.
- Secure, convenient remote access should be provided to physicians for at least results and documentation review. Preferably, physicians will be able to place orders and create new documentation as well.
- As much as possible, paper documents (such as outside results or referring provider notes) should be scanned and stored electronically, available from the patient's

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electronic record. Physicians should be trained in how to access and efficiently manipulate these documents.

- The number, placement, and configuration of workstations are important success factors. There should be an adequate number of workstations in comfortable, quiet, secure locations so that physicians do not have to leave their work area to work with a patient's electronic chart. Workstations should have enough memory and processing power to not slow physicians during data entry and results review. Generally, two or more screens speed the physicians' work by minimizing the amount of window and screen switching necessary.
- Similarly, the number and placement of printers, especially prescription printers, is critical for physician satisfaction. Physician work areas should have an adequate number of printers and physicians should be trained to use them. Printers should be named and labeled with a convention that makes it clear where a job will print.
- The organization should have a bring-your-own-device (BYOD) strategy that is clearly understood by physician users and promotes convenient, secure access to the patient record.

Theme 6: Design the system to support organizational goals, provider effectiveness, and organizational efficiency. Good system design was discussed as a critical success factor and another area in the dataset with rich coverage. A poor fit between the final system design and the physician and organizational work processes could have a significant adverse effect on physician adoption. Physicians' opinions regarding the effectiveness (usefulness) and efficiency (usability) of the system are

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important predictors of adoption. However, there can be tension between physician needs and other organizational needs, such as ensuring patient safety, compliance with external regulations, enhancement of organizational financial metrics, and improving the effectiveness and efficiency of non-physician clinical staff. Furthermore, because the business process rules of the organization become embedded in the design of the system, rules which may have been previously ignored or circumvented may now become enforced. This may result in complaints of increasing work, or even displacing work from one group to another.

Careful planning of key post-implementation work processes helps to avoid these issues. Group discussion among representatives of every role affected by a workflow ensures that organizational effectiveness and efficiency are maximized, and that inter-role compromises are understood and seen as fair and balanced. These future-state workflows should be designed to improve patient outcomes whenever possible, using process improvement techniques such as Lean and Six Sigma. Individuals involved in billing and coding should participate in these clinical discussions since billing tasks impact clinical staff workflow. Representatives from other groups that may need to be represented in these sessions or should review and approve the output are health information management, quality management, and compliance.

Orders management and rules management were seen as major determinants of physician adoption. The orders catalog, or set of all possible single orders, should be carefully designed with wide input from the medical staff. It should be complete, logical and unambiguous. Commonly used details of the order should be defaulted in, except

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where doing so would create a patient safety risk. Order sets, or orders grouped together for common clinical scenarios, should be clear, evidence-based, problem oriented, and as compact and simple as possible. Multiple variants of an order set for a single problem should be avoided, as it makes ordering more difficult and increases process variance. Rules management includes the alerting process that if not managed well can lead to alert fatigue and significant physician dissatisfaction. Unless rules related to clinical management and maintaining compliance are understood in advance of go-live and accepted by the medical staff, they can generate significant dissatisfaction and resistance.

Physician documentation design is a critical success factor. While the immediate availability of EHR documentation is a major plus for medical care, documentation which is too difficult to produce or to read can actually become an impairment to good patient care. The physician documentation strategy should allow for enough structured documentation for compliance and quality reporting, to facilitate post-hoc chart review and analysis, and to ensure adequate defense against malpractice allegations, while allowing enough flexibility and free-texting to capture nuances of the patient's care and to enhance physician efficiency. Structured documentation templates improve physician satisfaction, but can encourage inaccurate documentation if not created and used carefully. Policies should be in place to set expectations for appropriate documentation and to discourage problematic behaviors such as excessive copying and pasting. Documentation audits can ensure quality and head-off problems while they are still small. Dictation and/or speech recognition will be required in some settings to enhance physician effectiveness and satisfaction.

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Theme 7: Train users to get their work done efficiently and effectively with the system. Training physicians to use the EHR with enough facility to get their work done without aggravation and delay is a critical success factor. The more adept and comfortable the physicians are at go-live, the more likely they are to adopt the system into their work processes. During project startup, a detailed training plan should be created, which specifies details such as curriculum, required resources, timeline, competency verification, and training events. Since training will be a long-term need as new staff arrive and new system functionalities are added, the plan should address how this need will be organized and resourced on an on-going basis. The plan should address all phases of training, not just the formalized training which will occur just prior to go-live. Physician training includes multiple informal exposures to the system which should begin as soon as possible after system selection. Examples include demonstrations at multiple venues such as staff meetings or lunch-and-learn sessions. Early in implementation, the training plan should include classes in general computer skills for physicians who indicate a need for them. Because physicians are accustomed to giving direction and instruction to others in the workplace, some may be uncomfortable in assuming a subordinate student role in the presence of their co-workers. This resistance should be considered in the training plan. In addition to a required amount of classroom time, physician training should include alternate opportunities such as self-learning, mentoring, and 1-on-1 sessions. Formal physician training should begin in the last weeks before go-live, after the system has been completely designed and tested, and near enough to go-live that training will still be fresh in physicians' minds. Formalized

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physician training should be focused on workflow, rather than system functionality, emphasizing how to get their work completed efficiently. If possible, CME should be granted for attendance at formal training sessions. High-volume and high-revenue physicians should be identified early to ensure that they can use the system expertly at go-live. Super users will need to be addressed separately in the plan, because they will need to be trained early and in depth. It should be made clear to them that subsequently training their colleagues is expected and will be required. They must understand and agree to the time commitment when they agree to assume the role. Documentation of training completion and verification of competency should be required before physicians are granted full system access.

Theme 8: Transition the organization to the new system. From the standpoint of physician adoption, the major critical success factor in the adoption dataset during the go-live transition is physician support. Go-live can only occur smoothly and effectively for physicians after appropriate IT infrastructure is in place, the new system is built to specification and tested, and users are trained. Physician adoption will be negatively impacted by inadequate training of non-physician users whose roles directly impact patient care (nursing, ancillaries, unit secretaries, lab, pharmacy, imaging, etc.). If they see that other clinicians, on whom they depend to provide patient care, cannot use the EHR properly, physicians may quickly become resistant to a system they see as time-wasting and even potentially dangerous for patients. No matter how effective the physician training is leading up to go-live, physicians will have questions about how to get their work done efficiently with the new system. Highly available, physician-specific

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support will be needed for days or weeks after the EHR becomes live. Initially, coverage should be available around-the-clock, and can taper over the period of a few weeks.

Physicians should have at-the-elbow support for at least several days after go-live. An adequately-staffed physician-only help desk should be available by phone and drop-in visit during the intense support period. Physicians should help to manage the support load by arranging their work schedules so that at least one shift can be worked during periods of maximal support availability. Similarly, vacation and meeting travel should be avoided during this period. If unavoidable, support will have to be adjusted to accommodate.

Electronic and physical support artifacts (user manuals, short task-specific videos, workflow summaries, etc.) should be available by go-live at every physician workstation.

Expert clinical users (“super users”) should be available to staff physicians during the go-live period to troubleshoot workflow and design issues and to assist staff physicians with using the EHR. Ideally, the super users will include physicians with expertise in a variety of medical specialties who will be able to give specialty-specific assistance to their colleagues. An escalation of support plan should be created to shorten the time-to-resolution for physician help requests and to increase physician satisfaction at go-live.

Technical support should be available 24x7 at go-live to resolve physicians’ technical issues (logins, system performance, printer problems, etc.).

Theme 9: Support ongoing system assimilation and organizational transformation. The short term goal after go-live is assimilation of the EHR and associated new work processes into the organization. From a long term perspective, a process of mutual transformation will occur, in which the EHR and the users’ work

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processes adapt to each other. After go-live, the organization and the system will undergo a process of mutual transformation, a positive process which should be anticipated and planned for. Long-term physician adoption will be sustained by physicians' perception of the usefulness of the system. The governance structure will change after the system is implemented and stabilized, but some committees that support system maintenance and the evolution of the system over time must remain in place indefinitely, for example order set, clinical decision support, and work process redesign. The functions of other committees may be absorbed into the pre-implementation governance structure. For example, a physician advisory group may become a subcommittee of the medical executive committee, or the residual EHR steering committee functions will be largely handed over to the CIO and/or CMIO. The project management group may persist to manage upgrades and enhancements. Whatever the details, the organization's governance structure will be permanently changed. The data collected by and the process control implicit in the EHR should be used to drive ongoing continuous organizational improvement efforts through Lean and Six Sigma methodologies, creating a true learning organization that grows and develops over time, striving to streamline care processes, increase organizational efficiency, and improve patient care outcomes. A widely adopted EHR will become a strategic asset as the organization prepares itself for future scenarios such as accountable care, risk or population-based payment, and pay for performance.

Results from the Expert Panel

The panel revealed that they were quite experienced in facilitating physician adoption of electronic health records, and that for most this knowledge had been acquired

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primarily through experience. Each respondent had participated in more than five separate implementations as a physician leader. Collectively, they had participated in implementations of 14 different vendor systems. Every respondent had experience implementing Cerner systems, while the distribution of other system brands roughly paralleled the relative market shares held by these vendors. Only two of the 10 respondents (20%) related any formal training in the area of clinical informatics. One respondent held a graduate degree in health informatics, and one had attended short courses in informatics provided by AMDIS and by the ACPE. One respondent denied having formal training in informatics, but noted having completed graduate level training in computer science. One individual out of 10 had attained board certification in clinical informatics. Six out of 10 (or two thirds of the remaining nine subjects) indicated an intention to attain board certification within the next two years. See Appendix C for details.

The results of the Round 1 survey are shown in Appendix D. The table has been sorted first by the average response to each question, and then by the standard deviation of responses to each question. On this scale, 5.00 is equivalent to a response of "Strongly Agree." A standard deviation of 0.00 indicates that all respondents gave the same answer to the question. Appendix D shows us that our subjects generally agreed with the literature derived critical success factors, indicated by higher average scores. Likewise, standard deviations tend to be low, suggesting that on most questions the subjects were in agreement with each other as well as with the literature. Cronbach's alpha was calculated for this data set and confirms the high reliability, with a calculated value of 0.95.

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Responses to four of the survey items were in perfect agreement with the literature-derived CSFs: 5.00 average score and a standard deviation of 0. The consensus opinion of the expert panel was that the following items have the greatest impact on physician adoption:

- To promote physician adoption, the major critical success factors include: identify and cultivate physician and executive project leadership;
- To promote physician adoption, the major critical success factors include: train users to get their work done efficiently and effectively with the system;
- Key committees relating to physician adoption that should be included in a governance plan are: a physician advisory group composed of physician leadership, advising on physician-related issues such as clinical decision support and practice guidelines;
- In terms of modifying existing IT infrastructure to support project goals and requirements: system response times should be fast enough to not slow physicians.

Stated more simply, physician and executive leadership, training, a physician advisory group, and a fast electronic health record are the most important critical success factors for physician adoption.

On the other hand, 16 items failed agreement, utilizing criteria for agreement of a response average greater than or equal to 4.0 and a standard deviation less than or equal to 1.0. These items are shown in Appendix E.

A number of interesting changes occurred after the Round 2 survey. The number of items for which there was perfect agreement rose to 10 from four, shown in Appendix F.

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In addition to the initial four on Round 1, the following additional items achieved perfect agreement:

- in terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency: the details of clinical rules management and clinical decision support our critical component of system design that strongly impacts physician adoption;
- in terms of designing the system (status structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency: before go-live, the system should be tested by clinical staff using clinically realistic scenarios to validate the systems functionalities;
- in terms of transitioning the organization to the new system (six go-live, conversion, system activation): go-live can only occur smoothly and effectively for physicians after appropriate IT infrastructure is in place, the new system is built to specification and tested, and users are trained;
- in terms of transitioning the organization to the new system (go-live, conversion, system activation): physicians should have at-the-elbow support during and after go-live;
- in terms of transitioning the organization to the new system (go-live, conversion, system activation): technical support should be available 24X7 at go-live to resolve physicians' technical issues (logins, system performance, printer problems, etc.);

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- in terms of supporting ongoing system assimilation and organizational transformation: care processes should be streamlined and standardized to maximize system usefulness and physician adoption.

It is also interesting to note that the number of items of disagreement, defined as an average response score of greater than or equal to 4.0 and a standard deviation less than or equal to 1.0, fell to 11 from 16. The Round 2 items of disagreement are shown in Appendix G.

Since panelists were not required to complete each item on a survey, there are a few scattered missed items on Round 1, and more response count variation in Round 2 than Round 1. In Round 2, both the number of returned surveys and the number of completed items on some surveys were both reduced. One panelist did not begin a Round 2 survey before the cut-off date, and two panelists submitted surveys that were only partially complete. Again, the remaining panelists submitted surveys with a small number of apparently randomly skipped items. Although the response count on Round 1 was ten on nearly all items, the Round 2 response rate varied by item from seven to nine, with fewer completed items toward the end of the survey. For this reason, a Cronbach's alpha was not calculated for Round 2. Visual inspection of the data compared to Round 1, however, shows a higher level of agreement between the expert panel and the literature than was shown on Round 1.

On Round 1, the expert panel was encouraged to suggest additional critical success factors they felt were not included in the survey. This list of 14 factors was then presented to the panel in Round 2, where panelists indicated their level of agreement that these

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factors were important for physician adoption. The final list of critical success factors is shown in Appendix H. It is worth noting that two of the 14 failed our test for agreement. None of this group of factors achieved the level of perfect agreement. Inspection of the items suggests that many are repetitive of some items already in the survey list, or are extensions of these items.

Discussion

This work was not anticipated to blaze new theoretical territory, but rather to discuss how theory currently informs practical application, and to raise the question of how practical application might be used to inform theory. As Helmer notes, there is a concern among some scholars as to whether research on operational questions is even a scientific endeavor.(Helmer & Rescher, 1959; Helmer, 1963) Despite any uncertainties, after more than 20 years of research, the theoretical underpinnings of successful electronic health record implementation are fairly well-understood. Nonetheless, there is substantial variation in the ways that these concepts are modeled and described in the literature(Berg, 2001; Keshavjee, 2006), as well as substantial variations in how they are applied in the field. Meanwhile, adoption outcomes remain variable, and failure remains too frequent. (Keshavjee, 2006)

One of the central questions that this work intended to address was whether there is currently sufficient theoretical knowledge to inform operational practice in the area of physician adoption of newly-installed EHRs. For the practitioner who wishes to guide an EHR implementation to optimal physician adoption based on the recommendations in the literature, there are some challenges. Some of the adoption articles in the dataset present

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concepts at a high level, while others give advice that is very granular, concrete, and actionable, but limited in scope. Some articles discuss CSFs related to one aspect or phase of implementation, while others focus more heavily on different phases. At times, similar concepts were often expressed using different terminology or viewed from different perspectives. Much of the literature collected for this analysis was about dissecting what went wrong with implementations.(Kaplan & Harris-Salamone, 2009; Kumar & Aldrich, 2010; Lee, 2011; Levick et al., 2005; Lobach et al., 2005; Lorenzi & Riley, 2000; Ludwick & Doucette, 2009; Morton & Wiedenbeck, 2010; Schulman et al., 2007; Scott et al., 2005; Smith & Newell, 2002) This retrospective analysis can be helpful when it points to avoidable pitfalls or other specific, actionable items, or reminds practitioners of basic implementation principles. Unfortunately, knowing what not to do is not the same thing as knowing what to do. To go effectively from general concepts to specific operational tasks can require considerable skill and experience.

A superficial reading of adoption literature might leave the impression that knowledge of adoption CSFs is fragmented and inconsistent. In fact, Keshavjee goes so far as to say that the existing adoption literature is not even useful.(Keshavjee, 2006; Lobach et al., 2005) Perhaps Keshavjee's judgement is too harsh. The articles selected for this study's dataset include a variety of perspectives, including case reports, literature reviews, authoritative advice, etc. They cover the gamut from very pragmatic to theoretical. This might be a difficult mix to make sense of in a more traditional literature review, however using a thematic analysis allowed for the concepts discussed to be reduced to a more "atomic" level, creating a single conceptual dataset for all of these

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contextually dissimilar but thematically related materials. This work demonstrates that when atomized to the level of concepts and themes, the physician adoption literature is remarkably consistent, an assertion which is validated by the high levels of agreement between our expert practitioners and the literature.

Nonetheless, for someone new to the practice of physician adoption of electronic health records, a group which would include most physician leadership in institutions currently implementing EHRs, knowing *how* to do something (tasks, e.g. identify leadership, craft and document a governance plan, put committees in place and create charters, etc.) may be as important as knowing *what* to do (outcomes, e.g. create effective project governance). Because much of the implementation adoption literature presents advice at a conceptual or strategic level, and because this advice is often presented through various abstract models of how adoption works, novice practitioners of adoption may understand the desired outcomes, but not understand how to achieve them. Fortunately, the more recent literature appears to be moving in the direction of more specificity, providing further evidence for both the need and validity for this more pragmatic approach.

Not all authors agree that critical success factors for physician adoption can be specified at a high degree of granularity, nor that a generalizable set of CSFs can be determined. Berg expresses this skepticism, denying that there are critical success factors while describing certain tasks or milestones he believes are highly correlated with success.(Berg, 2001; Kawakami & Khai, 1997) However, practical experience and the thematic analysis output suggest that most implementations follow a fairly predictable

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pattern, with the predictability extending to a level of operational granularity. Certainly, at some level of detail, the items can become very specific to a particular institutional context and are thus not easily generalizable. The goal of this study was to stop short of that level, while identifying critical items with enough specificity that they would easily map to operational tasks. It seems reasonable, and perhaps even necessary, to leave site-specific idiosyncratic process details to be worked out at each site.

The articles selected for the dataset include a variety of perspectives, including case reports, literature reviews, authoritative advice, etc. They cover the gamut from very pragmatic to theoretical. This might be a difficult mix to make sense of in a more traditional literature review. Using a thematic analysis allowed for the concepts discussed to be reduced to a more “atomic” level, creating a single conceptual dataset for all of these contextually dissimilar but thematically related materials.

The final list of CSFs produced by the thematic analysis sometimes goes “one step” beyond the statements contained in the dataset. Those steps were kept as small as possible to get to an actionable statement. If an actionable statement was found in the dataset, then that would be used in the final CSFs. If no actionable statement was found, then the CSF was restated so that it was actionable. Care was taken not to “reach” beyond what seemed to be the intent of the dataset. This approach seems to be validated by the high level of agreement between the literature-based CSFs and the expert panel opinions.

The literature-derived list of CSFs is not meant to be an exhaustive physician adoption project plan. It intentionally only goes as far as the dataset went. It is likely that there are additional CSFs that would be seen on a hypothetical “complete list”. The

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expert panel extended this list with additional the suggestions shown in Appendix H.

Future extension of this work might be to expand this list to all tasks considered essential for physician adoption, as well as those which may sometimes be important for physicians adoption. The scope of such work would be beyond what was attempted in this study.

A potential limitation of this work is that it intentionally relates to inpatient, large-scale implementations. A physician informaticist might worry that critical success factors and smaller scale or ambulatory implementations differ significantly. This, however, does not appear to be the case until one begins to specify much more granular tasks than those included in this study. Therefore, it is likely that the results of this work would provide useful guidance for achieving physician adoption in a wide variety of implementation contexts.

Another potential challenge to acceptance of this work is the application of the Delphi technique. The use of the Delphi technique to develop a consensus opinion of experts was originally described as “an experiment” by Dalkey, Helmer and Brown while at the RAND Corporation.(Brown & Helmer-Hirschberg, 1964; Dalkey & Helmer, 1962; Helmer, 1963) Although there have been criticisms of the validity and reliability of this technique, it has become widely accepted in many disciplines and used successfully on numerous occasions.⁹ The key premise underlying a Delphi inquiry is that experts possess a body of knowledge that enables them to make better decisions than non-

⁹ Cuhls, 2003; Graham, Regehr, & Wright, 2003; Lam, Petri, & Smith, 2000; Meskill, Murphy, Shaw, & Casey, 2014; Murphy, Black, Lamping, Mckee, & Sanderson, 1998; Skulmoski, Hartman, & Krahn, 2007

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experts. In other words, the quality of their opinions is high, more closely approximating ideal or correct decisions in a situation. A further premise of the Delphi approach is that the consensus opinion of groups of interacting experts is more likely to be correct than the opinions of randomly selected individuals. In other words, there is a “collective wisdom” that can be tapped when expert groups are allowed to hear each other’s opinions. There are obvious logical limitations to this. A group of individuals with little or no knowledge in the area being questioned cannot be expected to produce a valid consensus. In this case, one would expect to see little coherence of opinion, demonstrated by a wide dispersion of opinion, thus the need for experts. Likewise, if the individuals are in face-to-face discussion, then a variety of group dynamics can come into play, resulting in a skewing of group opinion in a particular direction. By conducting the discussion through the use of survey instruments, the interaction becomes anonymous, eliminating the distorting effects of group dynamics. Using a panel to develop a consensus on critical success factors related to adoption and implementation is not a novel idea.(Ash et al., 2003; MacKinnon & Wasserman, 2009)

This study took a fairly routine approach to a Delphi study. The magnitude of this project was challenging, testing the patience and time availability of volunteer experts. The survey list of CSFs had to be compressed in order to get to a project scope that would be tolerable for a volunteer expert panel. In an effort to limit the total number of survey items, closely related concepts were consolidated into statements. These statements were phrased in such a way that the subject’s agreement indicated their belief that the statements described success factors for physician adoption, rather than general

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organizational success factors. This statement approach has been previously used by others, including Ash et.al.(Ash et al., 2003)

Because the scope of the study did not allow repeated iterations of the survey, only two iterations were employed. This limitation was enabled by constructing the first round survey from literature-suggested CSFs. This approach might be criticized for introducing a bias into the subsequent process by constraining the thinking of the experts, effectively “salting” their thinking. However, these CSFs were derived from articles written by individuals with adoption experience and expertise, so we were in fact simply beginning from an initial expert consensus rather than starting from scratch. In effect, additional “virtual” Delphi rounds have preceded the current work. Furthermore, our expert panel could have disagreed with the findings in the literature, or rejected the literature findings entirely.

The results, however, show that the group feedback, when combined with an opportunity to reconsider the items in a second round, changed the decision-making of the group and increased consensus. The expert panel’s level of agreement with most items was already quite high after the first round, supporting the validity of the Round 1 survey. Likewise, the number of additional CSFs suggested was fairly low, mostly representing refinements or extensions to those presented in the survey. This implies that the experts found the literature CSFs to be fairly complete.

The response counts on Round 2 items were lower than on Round 1, which may suggest fatiguing of our volunteer panel. Further rounds might well have necessitated a larger initial sample to compensate for subsequent attrition of subjects. Considering all of

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this, the decision to not pursue more than two Delphi rounds appears to have been vindicated.

Of course, the opinions of experts in this study are not necessarily correct or incorrect. They are simply the opinions of experts working in the field and may be biased by previous training, knowledge or experience; by the types of implementation environments where the experts have acquired most of their experience; and by the development of personal "beliefs" regarding implementation over time. The high degree of agreement among the expert panel and between the panel and the literature at least suggests a consistency of thought among these particular experts. Since a premise of the Delphi is that consensus expert opinions approximate "truth," we can take comfort that our expert panel is taking us in the right direction, even if we have not reached the final destination.

The chosen criteria for agreement (question mean response ≥ 4.0 and question standard deviation ≤ 1.0) may be considered arbitrary in that it essentially gives veto power to a single vote of "Disagree" by increasing the standard deviation beyond 1. This is, therefore, a sensitive test for disagreement. This makes the high level of agreement found even more remarkable. The gradation of agreement (mean responses of 4.0 to 5.0) may suggest is that there is a hierarchy of CSFs. Some may be highly and universally important, meriting response scores at or near 5.0. Others may be somewhat less important or even unimportant depending on circumstances, thus earning a lower score.

The final list of expert-endorsed CSFs is not a cookbook to be followed slavishly and precisely because there is enough variation in implementation scenarios to preclude a

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completely mechanical approach. However, this list should be detailed enough to begin the process of developing a standardized implementation framework that, if followed carefully, should result in a higher degree of success than trying to recreate a de novo adoption process with each implementation. In fact, the original concept behind this work was to develop an adoption checklist that could be used both to standardize the process for experienced practitioners and to guide and support the efforts of novices. Examples of such frameworks are seen in work by Mankins and, more recently, HIMSS.(HIMSS; Mankins, 1995)

The dataset reinforces, and the expert panel validates that there are definite pre-and post-implementation activities which are critical for successful physician adoption.(Ash et al., 2003; HIMSS; Mankins, 1995) Many of the CSFs should be completed or at least initiated during the planning or “startup” phase of the project, prior to the actual project kick-off. Unfortunately, in real-world implementations, the level of organizational activity and interest tends to be greatest during the implementation phase when vendor teams become visible and active and much is occurring relatively quickly. In order to ensure success, our results confirm that physician adoption begins at the earliest inceptions of the EHR implementation and extends well beyond go-live. In this author's experience, failure to create significant physician engagement early in the implementation project is a common occurrence. As a result, many of the tasks critical for success are considered or discussed but not completed. A useful future study might be to determine if the types and quantities of early physician involvement can in fact be

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correlated in an objective way with a successful adoption outcome, likely by employing a set of physician adoption metrics.

Summary and Conclusions

This work demonstrates that physician adoption critical success factors discovered through the application of systematic research found in current literature can be validated and extended with experiential, rule-based knowledge of practitioners expert in physician adoption. Extracting the CSFs from the literature using thematic analysis techniques allowed discovery and consolidation of concepts from semantically dissimilar research articles grounded in different conceptual models. Using a Delphi approach, we asked the experts to assess the literature CSFs against their collective experience.

By creating this opportunity for experienced implementers to inspect systematically acquired academic knowledge through the lens of practical experience, we hope to extend the adoption knowledge base by taking another step toward a concise, specific, operationally focused set of critical success factors that could be used to consistently and reliably promote physician adoption of electronic health records. This research is not meant to supplant or replace the important work already done in this area, but rather to extend it further in the direction of operational specificity. Although useful when expressed as a higher-level strategic framework, these CSFs take on additional utility for adoption practitioners when expressed in more granular, task-focused terms. Extending in this direction gives us the possibility to not only improve near-term adoption results, but also to begin the process of creating a framework for adoption that could eventually lead

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to a more standardized and efficient process. Further work could refine this data set to increase its completeness, validity, and reliability, and even ultimately to produce a checklist for EHR adoption.

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CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

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Appendix A

Selected Physician Adoption Citations

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Berg, 2001	Leonard & Sittig, 2007	Simborg, 2008
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CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Appendix B

Physician Adoption Critical Success Factors Code Set

- I. Determine the overall project vision, benefits to be attained (including strategic imperatives as well as current and anticipated external requirements), the specific goals for the projects and how these will be measured.

A. Benefits

1. *Chronic illness management*
2. *Errors*
3. *Surveillance*
4. *Preventive care*
5. *Value*
 - a) *Value exchange*
 - b) *Wins*
6. *Efficiency (Efficiencies)*
7. *Consistency*
8. *Medical errors*
9. *Medical records*
10. *Medication errors*
11. *Complete and coordinated resource*
12. *Sell benefits*
13. *duplicate orders*
14. *Availability (Availability of data)*
15. *Legibility (Legible)*
16. *Business case*

B. Requirements

1. *Regulatory requirements*
 - a) *Core measures*
 - b) *Compliance*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

- c) *Reporting*
- d) *Quality reporting*
- 2. *Require*
- C. **Goals**
 - 1. *Accountable care organization*
 - 2. *Outcomes*
 - 3. *Desirable vs. necessary*
 - 4. *Safety*
 - a) *Patient safety*
 - 5. *Strategy (Strategies)*
 - a) *Competition*
 - b) *Strategic plans*
 - 6. *Success (Successful)*
 - a) *Transformation of success criteria*
 - b) *Definitions of success*
 - c) *Widely used*
 - d) *Success for whom*
 - e) *Success measure*
 - 7. *Adoption*
 - a) *Useful*
 - b) *Usability*
 - c) *Social interactions*
 - d) *Critical success factor (CSF)*
 - e) *Age*
 - f) *Physician buy-in*
 - g) *psychological ownership*
 - h) *Practice site*
 - i) *Perceived*
 - j) *Ownership*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

- k) Foster ownership*
- l) Perceived usefulness (Perception of usefulness)*
- m) Perceived ease of use*
- n) User adoption*
- o) Buy-in*
- 8. *Objectives*
- 9. *End-user efficiency*
- 10. *Economic goal*
- 11. *Organizational goals*
- 12. *Measurable goals*
- a) Measures*
- (1) Metrics*
- (2) Metrics for success*
- D. Identify and cultivate physician and executive project leadership
- 1. **Leadership (leader, lead)**
- a) Physician leaders (Physician leader)*
- (1) Advocate*
- b) Key roles*
- (1) Champion (champions)*
- (a) Project champion*
- (b) Physician champion*
- (c) Clinical champions*
- (2) Consultants (Consultant)*
- c) Executive and clinical leaders*
- (1) Honesty, realism*
- (2) Visible*
- (3) Overcome constraints*
- (4) Commitment (Committed)*
- (a) Unwavering commitment*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

- (5) *Follow-through*
- (6) *Strong leaders*
- (7) *Senior management*
- (8) *Trust*
- d) *Clinical leadership*
 - (1) *Strong clinical leadership*
- e) *Administrative leadership (Administrative leaders)*
 - (1) *Top level leadership*
 - (2) *Management*
 - (3) *Management support*
 - (4) *Top management*
 - (5) *Executive leadership*
- E. Establish effective project governance & communications
 - 1. **Governance**
 - a) *Governance plan*
 - (1) *Characteristics*
 - (2) *Risk (risks)*
 - (3) *functions*
 - (a) *Alignment (Aligned)*
 - (b) *Manage attitudes*
 - (c) *Attitude*
 - (d) *Monitoring (Monitored)*
 - (e) *Accountability (Accountable)*
 - (f) *Assignment of responsibility*
 - (g) *Involvement (Involve, Involved, Involving)*
 - (h) *Participation (participate, Participative)*
 - (i) *User involvement*
 - (j) *User participation*
 - (k) *Contribution*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

- (l) Engagement*
- (m) End user involvement*
- (n) Clinician involvement*
- (o) Physician involvement*
- (p) Address barriers*
- (q) Hard to implement*
- (r) Efforts*
- (s) Working through problems*
- (t) Expensive*
- (u) Resources*
- b) Committees*
 - (1) Central management*
 - (a) Top down*
 - (2) EMR committee*
 - (a) Coordinating group*
 - (b) Vendor*
 - (c) Contractual tensions*
 - (d) Organizational support*
 - (e) Governance team*
 - (f) Project governance*
 - (g) Project team*
 - (h) Managed by a project-group [steering committee]*
- (3) Policies*
 - (a) Full compliance*
 - (b) CPOE*
 - (c) Computerized physician order entry*
 - (d) Required use*
 - (e) change process*
 - (f) Privacy and confidentiality (Privacy)*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

- (g) *Problem list*
- (h) *Downtime*
- (i) *Downtime protocols*
- (j) *Business continuity (Business continuity plan)*
- (k) *Mandate use*
- (l) *Documents management*
- (m) *Copy and paste policy*
- (n) *Access to whose data*
- (o) *Confidentiality*
- (p) *Defining the legal health record*
- (q) *Policy manual*
- (4) *Physician advisory committee (Physicians advisory committee)*
- (a) *Error reporting*
- (1) *Clinical decision support committee*
- (2) *Order set committee (Order sets subcommittee)*
- (3) *Process redesign committee*
- (a) *Processes (Process)*
- (b) *Process redesign*
- (4) *Design team*
- c) *Purpose*
 - (1) *Missions*
 - (2) *Common will*
 - (3) *Future needs*
 - (4) *Shared visionVision (Visions)*
- d) *Decision-making*
 - (1) *Local choice and decision-making (Local decision-making, Local involvement in decision-making, Local input)*
 - (2) *Forum for discussion*
 - (a) *Dialogue*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

(b) *Negotiation (negotiated, negotiations)*

(c) *Compromise*

(d) *Venting*

(3) *Consensus*

(4) *Conflicts*

(5) *Balance*

(a) *Give and take*

(b) *Fairness*

e) *Modification*

f) *Stakeholders*

(1) *Nursing or medical assistant staff*

(2) *Patients*

(a) *Patient*

(3) *Providers in the community*

(4) *Physicians*

(a) *Years in practice*

(b) *Workload*

(c) *Quality of work life*

(d) *Relationship to patient*

(e) *Reduces the time*

(f) *Redistribution of work*

(g) *Productivity*

(h) *Undermining professional standing*

(i) *Doctor-patient relationship*

(j) *Buy physician time*

(k) *Physician autonomy*

(l) *Physician loss of income*

(5) *People*

(6) *Future users*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

- (7) *Constituencies*
- (8) *Personnel*
- (9) *Hospitals*
- (10) *External stakeholders*
- (a) *External conditions*
- (b) *External reporting requirements*
- (11) *Stakeholders are engaged early*
- (12) *End-users*
- g) *On time*
- h) *Momentum*
- i) *Discovered*

2. Change management

- a) *Motivation (Motivating, Motivate)*
 - (1) *Need for change*
 - (2) *Enthusiasm*
 - (3) *Incentives (Incentive)*
- b) *Barriers*
 - (1) *Difficult (difficulties)*
 - (2) *Mourning*
- c) *Critical mass*
- d) *Relationships*
 - (1) *Health system relationship*
- e) *Organizational culture*
 - (1) *Feedback*
 - (2) *Culture*
 - (3) *Knowledge and understanding of practice culture*
 - (4) *Hands-off culture*
- f) *Social and behavioral factors*
- g) *Sociotechnical*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

- h) Resistance (Resistant)*
 - (1) Anxiety*
 - (2) frustration*
 - (3) Stressful*
 - (4) Skeptics (Skeptical)*
 - (5) Disruption (Disruptive)*
 - (6) Political agenda*
 - (7) Pressures*
- i) Interaction*
- j) Influence*
 - (1) Social networks*
 - (2) Key physicians*
 - (a) Key users*
- k) Organizational change*
 - (1) Change capability*
- l) Change management strategy*
- m) Change*
- n) Change relationships between (groups)*
- 3. Communication (communicate)**
 - a) Uncertainty*
 - b) Morale*
 - c) Constructive feedback*
 - d) Appreciation of this use*
 - e) User groups*
 - f) Expectations*
 - (1) Confirmation of expectations*
 - g) Educating (Educated)*
 - h) Message content*
 - i) Value proposition*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

- j) Urgency*
- k) Theme*
- l) Status*
- m) Staff meeting*
- n) Remind people of the benefits of an EHR system*
- o) Recognition*
- p) Posters*
- q) Persuasion*
- r) Newsletters*
- s) Project Name*
- t) Meetings*
- u) Discussion*
- v) Disagreements*
- w) Communication among users*
- x) Communication plan*
- y) Advertising (Advertisement)*

F. Assemble a competent and experienced project management team with day-to-day control of the project

1. Project management

- a) Phases (Phase, Phase in)*
 - (1) Arrival*
 - (2) Staffing*
 - (3) Go-live*
 - (4) Sequencing*
 - (5) Stages (staging)*
 - (6) Implementation*
 - (a) Big Bang*
 - (b) Implementation plan (Implementation planning)*
 - (7) Pre-implementation*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

- (8) *Post-implementation*
- (9) *Build phase*
- b) *Planning (Plan)*
 - (1) *Planning process*
 - (2) *Framework*
- c) *Assessment*
 - (1) *Analysis*
 - (2) *Performance reporting*
 - (3) *Performance data*
 - (4) *Organizational readiness*
 - (a) *Readiness*
 - (b) *Finances*
 - i) *Budget flexibility*
 - ii) *Revenue*
 - iii) *Cost*
 - iv) *Funding*
 - (c) *Expertise*
 - (d) *Preparedness*
- (5) *satisfaction*
- (6) *Users (User)*
 - (a) *User satisfaction*
 - (b) *User acceptance*
 - (c) *User attitude*
- (7) *Performance*
- (8) *Readiness assessment*
- (9) *Evaluation (Evaluate)*
 - (a) *Evaluation/reevaluation*
 - (b) *Evaluation metrics*
- (10) *Assess preparedness*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

d) *Project manager*

2. **Milestones**

3. **Scope**

a) *Project charter*

G. Modify existing IT Infrastructure to support project goals and requirements

1. **IT infrastructure**

a) *Redundancy*

b) *Networking*

c) *Integrated platform*

d) *Integration (integrates)*

e) *Identification number and password*

f) *Preloading (data preload, Preload, data migration, Entering existing data, Entering old data)*

g) *Web based data*

h) *Scanners*

i) *What's in it for me?*

j) *Technology staff*

k) *Technical problems*

l) *Technology*

m) *Compatibility*

n) *Accessible*

o) *Architecture*

p) *Data quality and migration*

q) *Emails*

r) *Existing systems*

s) *Fax servers*

t) *Fax messages*

u) *Hardware usability*

v) *Interfaces (interface)*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

<i>w)</i>	<i>Interoperability (Interoperable)</i>
<i>x)</i>	<i>Maintenance</i>
<i>y)</i>	<i>Malfunctions</i>
<i>z)</i>	<i>Printers</i>
<i>aa)</i>	<i>Response time</i>
<i>bb)</i>	<i>Reliability</i>
<i>cc)</i>	<i>Non-interoperable</i>
<i>dd)</i>	<i>Security</i>
<i>ee)</i>	<i>Server hardware</i>
<i>ff)</i>	<i>Silver bullet technologies</i>
<i>gg)</i>	<i>Signature pads</i>
<i>hh)</i>	<i>Stability</i>
<i>ii)</i>	<i>Sub notebooks</i>
<i>jj)</i>	<i>Tablet PCs</i>
<i>kk)</i>	<i>Technical infrastructure</i>
<i>ll)</i>	<i>Technical project</i>
<i>mm)</i>	<i>Thin client EHR workstation</i>
<i>nn)</i>	<i>Track issues</i>
<i>oo)</i>	<i>Workstations</i>
<i>pp)</i>	<i>Internet connection</i>
<i>qq)</i>	<i>Internet access</i>
<i>rr)</i>	<i>Equipment</i>
<i>ss)</i>	<i>End-user hardware</i>
<i>tt)</i>	<i>Connect</i>
<i>uu)</i>	<i>Computer</i>
<i>vv)</i>	<i>Connectivity</i>
<i>ww)</i>	<i>Password</i>
<i>xx)</i>	<i>Mobile devices</i>
<i>yy)</i>	<i>Mapping printers</i>

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

zz) *Laptop devices*

aaa) *Local area network*

bbb) *Remote access*

ccc) *Access*

ddd) *Bandwidth*

eee) *Authorization (authorize)*

(1) *Authorization procedures*

(2) *Audit trails*

(3) *Login (Log on and off)*

H. Design the system to support organizational goals, provider effectiveness, and organizational efficiency

1. System design

a) *Decision support*

b) *Inadequate design*

c) *Adaptation*

d) *Customization (customize, Customized)*

e) *Clinical content*

(1) *Clinical decision support*

(a) *Evidence-based clinical decision making*

i) *Guidelines*

ii) *Evidence*

iii) *Evidence-based*

f) *Escape routes*

g) *Results*

h) *Clinical data*

i) *Testing (Tested)*

j) *Messaging (Messages)*

k) *Detail*

l) *Ease of use*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

- m) Effectiveness*
- n) Orders management*
 - (1) Standard order sets*
 - (2) Medication orders*
 - (3) Order sets*
- o) Rules management*
 - (1) Expert rules*
 - (2) Maintenance of rules*
 - (3) Hard stops*
 - (4) Alerts (Alert)*
 - (a) Drug interaction and allergy alerts*
 - (b) Alert fatigue*
- p) Documentation*
 - (1) structured documentation*
 - (2) Templates (Template)*
 - (a) Template*
 - (3) Chart notes*
 - (4) Free text*
 - (5) Discrete fields*
 - (6) Clinical documentation*
 - (7) Clinician notes*
 - (8) Dictation*
 - (9) Documentation requirements*
- q) Billing and coding*
 - (1) Advanced beneficiary notice (ABN)*
 - (2) Noncoverage*
 - (3) Charges*
- r) Workflow (workflows)*
 - (1) Paper*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

- (a) *Paperless*
- (2) *Patient care process*
- (3) *secondary work processes*
- (4) *Pharmacy protocols*
- (5) *Prescription refill*
- (6) *Fit*
- (7) *Discharge workflow*
- (8) *Clinical processes*
- (9) *Clinical workflow*
- (10) *Impact*
- (11) *Clinical specialty*
- (12) *Information flows*
- (13) *Realignment*
- (14) *Flexibility and mobility of work*
- (15) *Clinical*
- (16) *Medication delivery workflow*
- (17) *Medication delivery*
- (18) *match work processes*
- (19) *Key workflows*
- (20) *Working routines*
- (21) *Work processes*
- (22) *Work tasks*
- (23) *Workflow impact*
- (24) *Workflow exceptions*
- s) *Time*
- (1) *Time for patient care*
- (2) *Timelines (Timeline)*
- (3) *Time buffers*
- t) *Reconfigure*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

- u) Links*
- v) Improvisation*
- w) Localization*
- x) Meaningful use*
- y) Viewing*
- z) Test and imaging results*
- aa) Forms*
- bb) Flexibility*
- cc) Redesign*
- dd) Technology usability factors*
- ee) User interface*
- ff) System behavior*
- gg) Design*
- (l) Compensating (Compensate)*
- hh) Development*

I. Train users to get their work done efficiently and effectively with the system

1. Training (train, trained)

- a) Self learning*
- b) Prior computer experience*
- c) Mentoring*
- d) Internet Self efficacy*
- e) General computer knowledge*
- f) CME*
- g) Experience*
- h) Instruction (Instructions)*
- i) Computer skills*
- j) Computer literacy*
- k) Comfort with and knowledge of IT*
- l) Training manual*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

- m) Train the trainer*
- n) Training curriculum*
- o) Clinician trainers*

J. Transition the organization to the new system

1. Support (supported)

- a) Help desk support*
- b) Help desk*
- c) Technical support*
- d) Translators*
- e) Expert support*
- f) Electronic knowledge artifacts*
- g) Electronic technical artifacts*
- h) Medical experts support*
- i) Escalation of support plan*
- j) Elbow support*
- k) Physicians support*
- l) At-the-elbow support*
- m) Super users*
- n) 24x7 support*

K. Support ongoing system assimilation and organizational transformation

1. Transformation (Transform)

- a) Transition*
- b) Evolving (evolve)*
- c) Standardized care processes*
- d) Mutual transformation*
 - (1) Mutual*
- e) Configurable*
- f) Strategic asset*
- g) Continuous improvement*

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

(1) Lean

(2) Six Sigma

(3) improvement

(4) Quality

(5) quality improvement

h) System redesign strategies

i) Streamlined

j) Streamline processes

k) Standardization (Standardized)

2. Assimilation

3. Learning (Learn)

a) Mutual learning

b) Continuous learning

c) Organizational development

d) Lessons learned

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Appendix C

Expert Panel Characteristics

Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Subject 7	Subject 8	Subject 9	Subject 10
How many electronic health record implementations have you participated in as a physician leader (CMIO, committee chair, physician champion, etc.)? Please count significant involvement as one implementation, even if you did not participate in the entire project from beginning to end.									
>5	>5	>5	>5	>5	>5	>5	>5	>5	>5
Which vendors' systems have you implemented? Please check all that apply.									
Cerner Epic Meditech Siemens	Cerner	Cerner	Cerner	Cerner Eclipsys TDS	Cerner Quadramed Military system	Cerner Epic Eclipsys	Cerner GE eCW Quadramed Cliniflow	Cerner Eclipsys	Cerner, Medhost
Do you have specific, formal training (graduate level or fellowship) in clinical informatics?									
Yes	No	No	Yes	No	No	No	No		No
Please indicate any degrees or certificates held.									
CMIO bootcamp via ACPE and AMDIS	Formal training in computer science		MBA Health Informatics						CMIO Bootcamp (AMDIS, ACPE)
Are you board Certified in Clinical Informatics?									
No	No	No	No	No	No	Yes	No		No
Do you plan to sit for Board Certification in Clinical Informatics in 2014 or 2015?									
No	Yes	No	Yes	Yes	No	No	Yes		Yes

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Appendix D

Round 1 Question Ranking (with question detail)

Question Number	Question		Count	Average	StDev
Round 1					
2	To promote physician adoption, the major critical success factors include:	Identify and cultivate physician and executive project leadership.	10	5.00	0.00
7	To promote physician adoption, the major critical success factors include:	Train users to get their work done efficiently and effectively with the system.	10	5.00	0.00
24	Key committees relating to physician adoption that should be included in a governance plan are:	A physician advisory group composed of physician leadership, advising on physician-related issues such as clinical decision support and practice guidelines.	10	5.00	0.00
45	In terms of modifying existing IT Infrastructure to support project goals and requirements:	System response times should be fast enough to not slow physicians.	10	5.00	0.00
3	To promote physician adoption, the major critical success factors include:	Establish effective project governance & communications.	10	4.90	0.32
21	In terms of establishing effective project governance & communications:	The governance plan should seek to promote wide involvement of physician staff in the project, thus encouraging dialogue, clinical and administrative alignment, conflict resolution, and consensus development.	10	4.90	0.32
25	Key committees relating to physician adoption that should be included in a governance plan are:	A clinical transformation group focused on interdisciplinary issues such as workflows and business process improvement.	10	4.90	0.32
54	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	Key future state workflows should be decided and documented through discussions among the stakeholders affected.	10	4.90	0.32
57	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	The details of clinical rules management and clinical decision support are a critical component of system design that strongly impacts physician adoption.	10	4.90	0.32

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 1 Question Ranking (with question detail)

Question Number	Question		Count	Average	StDev
60	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	Before go-live, the system should be tested by clinical staff using clinically realistic scenarios to validate the system's functionalities.	10	4.90	0.32
74	In terms of training users to get their work done efficiently and effectively with the system:	Physician training should be focused on workflow, rather than system functionality, emphasizing how to get their work completed efficiently.	10	4.90	0.32
83	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	Technical support should be available 24x7 at go-live to resolve physicians' technical issues (logins, system performance, printer problems, etc.)	10	4.90	0.32
89	In terms of supporting ongoing system assimilation and organizational transformation:	A widely used and smoothly functioning system will become a strategic asset as healthcare organizations prepare themselves for future scenarios such as accountable care, risk or population-based payment, and pay for performance.	10	4.90	0.32
4	To promote physician adoption, the major critical success factors include:	Assemble a competent and experienced project management team with day-to-day control of the project.	10	4.80	0.42
9	To promote physician adoption, the major critical success factors include:	Support ongoing system assimilation and organizational transformation.	10	4.80	0.42
15	To enhance physician adoption, project goals should include a significant percentage which are related to:	Physician productivity and efficiency.	10	4.80	0.42
36	The project management group should be responsible for:	Monitoring and reporting progress toward deadlines and goals, using periodic assessments and pre-determined metrics for each goal.	10	4.80	0.42
50	In terms of modifying existing IT Infrastructure to support project goals and requirements:	Internet access should be resistant to outages and slow-downs.	10	4.80	0.42
58	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	Orders management, especially order set creation are critical for successful system design and physician adoption.	10	4.80	0.42

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 1 Question Ranking (with question detail)

Question Number	Question		Count	Average	StDev
59	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	Order sets should be designed based on current best evidence and recommendations, minimizing unexplained variations in practice.	10	4.80	0.42
65	In terms of training users to get their work done efficiently and effectively with the system:	Training will be a long-term need as new staff arrive and new system functionalities are added.	10	4.80	0.42
78	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	Physicians should have at-the-elbow support during and after go-live.	10	4.80	0.42
43	In terms of modifying existing IT Infrastructure to support project goals and requirements:	Secure, robust wireless network access should be available in every location where it will be needed and will be able to support the load during peak usage times.	10	4.80	0.63
48	In terms of modifying existing IT Infrastructure to support project goals and requirements:	There should be enough workstations available for physicians in secure, quiet areas that they do not need to leave their work area to use the EHR.	10	4.80	0.63
63	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	The system should be designed to improve provider efficiency whenever possible, and to minimize the impact where processes will take more time.	10	4.80	0.63
6	To promote physician adoption, the major critical success factors include:	Design the system (data structures, user interfaces, workflows) to support organizational goals, provider effectiveness, and organizational efficiency.	10	4.70	0.48
8	To promote physician adoption, the major critical success factors include:	Transition the organization to the new system.	10	4.70	0.48
16	To enhance physician adoption, project goals should include a significant percentage which are related to:	Physician and other end-user satisfaction.	10	4.70	0.48
20	In terms of establishing effective project governance & communications:	A written governance plan should be prepared which delineates and details the committees to be formed or restructured and their interrelationships, thus defining the decision-making process for the project.	10	4.70	0.48

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 1 Question Ranking (with question detail)

Question Number	Question		Count	Average	StDev
23	Key committees relating to physician adoption that should be included in a governance plan are:	An EHR steering committee composed of senior clinical, executive, and project management leadership.	10	4.70	0.48
33	The project management group should be responsible for:	Creating and maintaining a detailed project plan.	10	4.70	0.48
49	In terms of modifying existing IT Infrastructure to support project goals and requirements:	Physicians should have single sign on technology to minimize repeated system authentication during the work day.	10	4.70	0.48
56	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	Personnel involved in charge capture and billing should participate in workflow discussions to ensure that charge capture is facilitated by the workflows.	10	4.70	0.48
64	In terms of training users to get their work done efficiently and effectively with the system:	During project startup, a detailed training plan should be created, which specifies details such as curriculum, required resources, timeline, competency verification, and training events.	10	4.70	0.48
66	In terms of training users to get their work done efficiently and effectively with the system:	Documentation of training completion and verification of competency should be required before physicians are granted full system access.	10	4.70	0.48
68	In terms of training users to get their work done efficiently and effectively with the system:	High-volume and high-revenue physicians should be identified early and can use the system expertly at go-live.	10	4.70	0.48
81	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	Expert clinical users ("super users") should be available to staff physicians during the go-live period to troubleshoot workflow and design issues and to assist staff physicians with using the EHR.	10	4.70	0.48
82	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	An escalation of support plan should be created to shorten the time-to-resolution for physician help requests and to increase physician satisfaction at go-live.	10	4.70	0.48
84	In terms of supporting ongoing system assimilation and organizational transformation:	Long-term adoption will be sustained by physicians' perception of the usefulness of the system.	10	4.70	0.48
17	To enhance physician adoption, project goals should include a significant percentage which are related to:	Should be specific and measurable.	10	4.60	0.52

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 1 Question Ranking (with question detail)

Question Number	Question		Count	Average	StDev
30	Since it would be difficult or impossible to achieve organizational objectives related to the EHR otherwise, physician use of the EHR should be a required condition of continued clinical privileges.		10	4.60	0.52
73	In terms of training users to get their work done efficiently and effectively with the system:	If possible, CME should be granted for attendance at formal training sessions.	10	4.60	0.52
87	In terms of supporting ongoing system assimilation and organizational transformation:	The data collected by and the process control implicit in the EHR should be used to drive ongoing continuous organizational improvement efforts through Lean and Six Sigma methodologies, creating a true learning organization that grows and develops over time.	10	4.60	0.52
26	Key committees relating to physician adoption that should be included in a governance plan are:	An orders management committee to create and maintain order catalogues and order sets.	10	4.60	0.70
31	A project management group (project management office, project management team, project management committee) led by an experienced individual should be created by the institution.		10	4.60	0.70
41	In terms of modifying existing IT Infrastructure to support project goals and requirements:	Interfaces to existing systems should be completed, tested, and users trained on how to access these systems prior to go-live.	10	4.60	0.70
51	Regarding printers:	Placement and number should be carefully planned.	10	4.60	0.70
85	In terms of supporting ongoing system assimilation and organizational transformation:	After go-live, the organization and the system will undergo a process of mutual transformation, a creative process which should be anticipated and planned for.	10	4.60	0.70
88	In terms of supporting ongoing system assimilation and organizational transformation:	Care processes should be streamlined and standardized to maximize system usefulness and physician adoption.	10	4.60	0.84
1	To promote physician adoption, the major critical success factors include:	Determine the overall project vision, benefits expected to be obtained, and specific project goals and metrics.	10	4.50	0.71

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 1 Question Ranking (with question detail)

Question Number	Question		Count	Average	StDev
44	In terms of modifying existing IT Infrastructure to support project goals and requirements:	Physicians should have secure access to the system from outside the institution that will at least allow them to review results and documentation and preferably allow them to place orders, and to create chart notes.	10	4.50	0.71
76	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	Physician adoption will be negatively impacted by inadequate training of non-physician users whose roles directly impact patient care (nursing, ancillaries, unit secretaries, lab, pharmacy, imaging, etc.).	10	4.50	0.71
27	Key committees relating to physician adoption that should be included in a governance plan are:	A policy committee to update or create organizational policies which will be affected by the EHR.	8	4.50	0.76
32	To ensure alignment and commitment, the project management lead should be employed by (or contracted exclusively to) the institution and report to the executive sponsor and the steering committee.		10	4.50	0.97
72	In terms of training users to get their work done efficiently and effectively with the system:	In addition to a required amount of classroom time, physician training should include alternate opportunities such as self-learning, mentoring, and 1-on-1 sessions.	10	4.50	0.97
75	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	Go-live can only occur smoothly and effectively for physicians after appropriate IT infrastructure is in place, the new system is built to specification and tested, and users are trained.	10	4.50	0.97
70	In terms of training users to get their work done efficiently and effectively with the system:	Super users should be trained early and in depth and should understand that training their colleagues is expected and will be required.	10	4.50	1.08
69	In terms of training users to get their work done efficiently and effectively with the system:	Early in implementation, separate classes in general computer skills should be offered to physicians who indicate a need for them.	10	4.40	0.52
14	To enhance physician adoption, project goals should include a significant percentage which are related to:	Patient care outcomes.	10	4.40	0.70
53	Regarding printers:	The printer naming convention should allow users to identify the location of the printer before they print.	10	4.40	0.70

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 1 Question Ranking (with question detail)

Question Number	Question		Count	Average	StDev
80	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	Electronic and physical support artifacts (user manuals, short task-specific videos, workflow summaries, etc.) should be available by go-live at every physician workstation.	10	4.40	0.70
67	In terms of training users to get their work done efficiently and effectively with the system:	Physician training includes system demonstrations which should begin as soon as possible after system selection at multiple venues such as staff meetings, lunch-and-learn sessions, etc.	10	4.40	0.97
39	The project management group should be responsible for:	An overall assessment of organizational readiness during the project startup phase to identify key issues that will need to be addressed in the project plan.	9	4.33	1.32
29	A communications plan that specifies the content of messages to be delivered, the groups that should receive messages, the media for messages (newsletters, staff meetings, email, etc.), and the timing of messaging should be completed in the early, start-up phase of the project.		10	4.30	0.48
42	In terms of modifying existing IT Infrastructure to support project goals and requirements:	Historical patient data should be preloaded into the system prior to go-live.	10	4.30	0.67
55	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	Process improvement techniques such as Lean should be employed to ensure optimal future-state workflows.	10	4.30	0.67
61	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	Physician documentation should be designed with sufficient structured sections to capture desired data and with sufficient free text sections to capture nuances of care and to maintain physician efficiency.	10	4.30	0.67
11	Physician participation in developing a shared organizational vision, explicitly delineated expected benefits, and specific measurable goals:	Should be sought early in the process before project requirements and scope are set.	10	4.30	0.69
34	The project management group should be responsible for:	Performing an analysis of risks and mitigation strategies for the high-profile risks.	10	4.30	1.25

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 1 Question Ranking (with question detail)

Question Number	Question		Count	Average	StDev
37	The project management group should be responsible for:	Managing project resources.	10	4.30	1.25
38	The project management group should be responsible for:	Overseeing and coordinating with vendor project management teams.	10	4.30	1.25
10	Physician participation in developing a shared organizational vision, explicitly delineated expected benefits, and specific measurable goals:	Motivates the physician staff to become involved in the implementation.	10	4.20	0.68
18	Physician adoption will be fostered by discussing potential EHR benefits with the medical staff.		10	4.20	0.92
71	In terms of training users to get their work done efficiently and effectively with the system:	Formal physician training should begin in the last weeks before go-live, after the system has been completely designed and tested, and near enough to go-live that training will still be fresh in physicians' minds.	10	4.20	1.03
52	Regarding printers:	Prescription printers should be placed in secure areas and properly configured prior to go-live.	10	4.20	1.23
13	To enhance physician adoption, project goals should include a significant percentage which are related to:	Patient safety.	10	4.10	0.57
12	Physician participation in developing a shared organizational vision, explicitly delineated expected benefits, and specific measurable goals:	Can be fostered by involving physicians in the development of a detailed planning document such as a project charter.	10	4.10	0.67
19	In terms of establishing effective project governance & communications:	Project governance and stakeholder communications are two of the principal means for organizational change management.	10	4.10	0.88
22	In terms of establishing effective project governance & communications:	Governance planning should be completed in the early, start-up phase of the project.	10	4.10	0.99
28	The organization should have a written communications plan, created and administered by a communications committee.		10	4.10	0.99

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 1 Question Ranking (with question detail)

Question Number	Question		Count	Average	StDev
86	In terms of supporting ongoing system assimilation and organizational transformation:	Committees must remain in place indefinitely that support system maintenance and evolution over time, e.g. order set, clinical decision support, process improvement, etc.	10	4.10	1.20
35	The project management group should be responsible for:	Ensuring that a detailed project charter has been developed (or creates the charter with review and approval), which delineates the project purpose, goals, requirements, scope, deliverables, resources, and timeline.	10	4.10	1.29
79	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	Physicians should arrange work schedules so that at least one shift can be worked during periods of maximal support availability.	10	4.10	1.29
5	To promote physician adoption, the major critical success factors include:	Modify existing IT Infrastructure to support project goals and requirements.	10	4.00	1.05
47	In terms of modifying existing IT Infrastructure to support project goals and requirements:	Paper documents should be scanned and stored electronically, with physicians trained on how to access these documents.	10	4.00	1.05
77	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	An adequately staffed physician-only help desk, accessible 24x7 by phone or drop-in, should be available for at least 1 week after go-live.	10	4.00	1.63
62	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	Network-level speech recognition should be provided to physicians who request it.	10	3.90	0.74
40	Due to the complexity of the implementation process, the intensive need for resources, and the highly integrated nature of modern EHRs, at the hospital level it is usually preferable to do a “big bang” implementation, bringing the entire system up for all users at once.		10	3.90	1.10
46	In terms of modifying existing IT Infrastructure to support project goals and requirements:	Physician workstations should have at least 2 monitors to minimize switching between screen displays, with screen sizes and resolutions matched to the EHR’s display capabilities.	10	3.20	0.63

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Appendix E

Round 1 Delphi items which failed agreement

Question Number	Question		Count	Average	StDev
70	In terms of training users to get their work done efficiently and effectively with the system:	Super users should be trained early and in depth and should understand that training their colleagues is expected and will be required.	10	4.50	1.08
39	The project management group should be responsible for:	An overall assessment of organizational readiness during the project startup phase to identify key issues that will need to be addressed in the project plan.	9	4.33	1.32
34	The project management group should be responsible for:	Performing an analysis of risks and mitigation strategies for the high-profile risks.	10	4.30	1.25
37	The project management group should be responsible for:	Managing project resources.	10	4.30	1.25
38	The project management group should be responsible for:	Overseeing and coordinating with vendor project management teams.	10	4.30	1.25
71	In terms of training users to get their work done efficiently and effectively with the system:	Formal physician training should begin in the last weeks before go-live, after the system has been completely designed and tested, and near enough to go-live that training will still be fresh in physicians' minds.	10	4.20	1.03
52	Regarding printers:	Prescription printers should be placed in secure areas and properly configured prior to go-live.	10	4.20	1.23
86	In terms of supporting ongoing system assimilation and organizational transformation:	Committees must remain in place indefinitely that support system maintenance and evolution over time, e.g. order set, clinical decision support, process improvement, etc.	10	4.10	1.20
35	The project management group should be responsible for:	Ensuring that a detailed project charter has been developed (or creates the charter with review and approval), which delineates the project purpose, goals, requirements, scope, deliverables, resources, and timeline.	10	4.10	1.29
79	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	Physicians should arrange work schedules so that at least one shift can be worked during periods of maximal support availability.	10	4.10	1.29
5	To promote physician adoption, the major critical success factors include:	Modify existing IT Infrastructure to support project goals and requirements.	10	4.00	1.05
47	In terms of modifying existing IT Infrastructure to support project goals and requirements:	Paper documents should be scanned and stored electronically, with physicians trained on how to access these documents.	10	4.00	1.05

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 1 Delphi items which failed agreement

Question Number	Question		Count	Average	StDev
77	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	An adequately staffed physician-only help desk, accessible 24x7 by phone or drop-in, should be available for at least 1 week after go-live.	10	4.00	1.63
62	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	Network-level speech recognition should be provided to physicians who request it.	10	3.90	0.74
40	Due to the complexity of the implementation process, the intensive need for resources, and the highly integrated nature of modern EHRs, at the hospital level it is usually preferable to do a “big bang” implementation, bringing the entire system up for all users at once.		10	3.90	1.10
46	In terms of modifying existing IT Infrastructure to support project goals and requirements:	Physician workstations should have at least 2 monitors to minimize switching between screen displays, with screen sizes and resolutions matched to the EHR’s display capabilities.	10	3.20	0.63

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Appendix F

Round 2 Items with Panel Agreement

Question Number	Question		Count	Average	StDev
7	To promote physician adoption, the major critical success factors include:	Identify and cultivate physician and executive project leadership.	9	5.00	0.00
25	To promote physician adoption, the major critical success factors include:	Train users to get their work done efficiently and effectively with the system.	8	5.00	0.00
48	Key committees relating to physician adoption that should be included in a governance plan are:	A physician advisory group composed of physician leadership, advising on physician-related issues such as clinical decision support and practice guidelines.	9	5.00	0.00
31	In terms of modifying existing IT Infrastructure to support project goals and requirements:	System response times should be fast enough to not slow physicians.	9	5.00	0.00
70	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	The details of clinical rules management and clinical decision support are a critical component of system design that strongly impacts physician adoption.	8	5.00	0.00
53	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	Before go-live, the system should be tested by clinical staff using clinically realistic scenarios to validate the system's functionalities.	8	5.00	0.00
52	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	Go-live can only occur smoothly and effectively for physicians after appropriate IT infrastructure is in place, the new system is built to specification and tested, and users are trained.	7	5.00	0.00
19	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	Physicians should have at-the-elbow support during and after go-live.	7	5.00	0.00
79	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	Technical support should be available 24x7 at go-live to resolve physicians' technical issues (logins, system performance, printer problems, etc.)	6	5.00	0.00

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 2 Items with Panel Agreement

Question Number	Question		Count	Average	StDev
40	In terms of supporting ongoing system assimilation and organizational transformation:	Care processes should be streamlined and standardized to maximize system usefulness and physician adoption.	7	5.00	0.00
45	To promote physician adoption, the major critical success factors include:	Assemble a competent and experienced project management team with day-to-day control of the project.	9	4.89	0.33
65	In terms of establishing effective project governance & communications:	The governance plan should seek to promote wide involvement of physician staff in the project, thus encouraging dialogue, clinical and administrative alignment, conflict resolution, and consensus development.	9	4.89	0.33
63	Key committees relating to physician adoption that should be included in a governance plan are:	A clinical transformation group focused on interdisciplinary issues such as workflows and business process improvement.	8	4.88	0.35
32	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	Key future state workflows should be decided and documented through discussions among the stakeholders affected.	8	4.88	0.35
69	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	Orders management, especially order set creation are critical for successful system design and physician adoption.	8	4.88	0.35
14	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	Order sets should be designed based on current best evidence and recommendations, minimizing unexplained variations in practice.	8	4.88	0.35
71	In terms of training users to get their work done efficiently and effectively with the system:	Physician training should be focused on workflow, rather than system functionality, emphasizing how to get their work completed efficiently.	8	4.88	0.35
12	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	An adequately staffed physician-only help desk, accessible 24x7 by phone or drop-in, should be available for at least 1 week after go-live.	7	4.86	0.38

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 2 Items with Panel Agreement

Question Number	Question		Count	Average	StDev
35	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	An escalation of support plan should be created to shorten the time-to-resolution for physician help requests and to increase physician satisfaction at go-live.	7	4.86	0.38
5	In terms of supporting ongoing system assimilation and organizational transformation:	Long-term adoption will be sustained by physicians' perception of the usefulness of the system.	7	4.86	0.38
46	In terms of supporting ongoing system assimilation and organizational transformation:	A widely used and smoothly functioning system will become a strategic asset as healthcare organizations prepare themselves for future scenarios such as accountable care, risk or population-based payment, and pay for performance.	7	4.86	0.38
86	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	Expert clinical users ("super users") should be available to staff physicians during the go-live period to troubleshoot workflow and design issues and to assist staff physicians with using the EHR.	6	4.83	0.41
24	To promote physician adoption, the major critical success factors include:	Establish effective project governance & communications.	9	4.78	0.44
21	To promote physician adoption, the major critical success factors include:	Design the system (data structures, user interfaces, workflows) to support organizational goals, provider effectiveness, and organizational efficiency.	9	4.78	0.44
9	To enhance physician adoption, project goals should include a significant percentage which are related to:	Physician productivity and efficiency.	9	4.78	0.44
43	Key committees relating to physician adoption that should be included in a governance plan are:	An EHR steering committee composed of senior clinical, executive, and project management leadership.	9	4.78	0.44
6	Key committees relating to physician adoption that should be included in a governance plan are:	An orders management committee to create and maintain order catalogues and order sets.	9	4.78	0.44

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 2 Items with Panel Agreement

Question Number	Question	Count	Average	StDev
49	To ensure alignment and commitment, the project management lead should be employed by (or contracted exclusively to) the institution and report to the executive sponsor and the steering committee.	9	4.78	0.44
68	The project management group should be responsible for:	9	4.78	0.44
	Monitoring and reporting progress toward deadlines and goals, using periodic assessments and pre-determined metrics for each goal.			
26	In terms of modifying existing IT Infrastructure to support project goals and requirements:	9	4.78	0.44
	Physicians should have secure access to the system from outside the institution that will at least allow them to review results and documentation and preferably allow them to place orders, and to create chart notes.			
1	In terms of modifying existing IT Infrastructure to support project goals and requirements:	9	4.78	0.44
	Internet access should be resistant to outages and slow-downs.			
87	In terms of modifying existing IT Infrastructure to support project goals and requirements:	9	4.78	0.67
	Secure, robust wireless network access should be available in every location where it will be needed and will be able to support the load during peak usage times.			
85	In terms of modifying existing IT Infrastructure to support project goals and requirements:	9	4.78	0.67
	There should be enough workstations available for physicians in secure, quiet areas that they do not need to leave their work area to use the EHR.			
75	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	8	4.75	0.46
	Personnel involved in charge capture and billing should participate in workflow discussions to ensure that charge capture is facilitated by the workflows.			
29	In terms of training users to get their work done efficiently and effectively with the system:	8	4.75	0.46
	During project startup, a detailed training plan should be created, which specifies details such as curriculum, required resources, timeline, competency verification, and training events.			
55	In terms of training users to get their work done efficiently and effectively with the system:	8	4.75	0.46
	Documentation of training completion and verification of competency should be required before physicians are granted full system access.			

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 2 Items with Panel Agreement

Question Number	Question		Count	Average	StDev
18	In terms of training users to get their work done efficiently and effectively with the system:	If possible, CME should be granted for attendance at formal training sessions.	8	4.75	0.46
39	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	The system should be designed to improve provider efficiency whenever possible, and to minimize the impact where processes will take more time.	8	4.75	0.71
22	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	Physicians should arrange work schedules so that at least one shift can be worked during periods of maximal support availability.	7	4.71	0.49
13	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	Physician adoption will be negatively impacted by inadequate training of non-physician users whose roles directly impact patient care (nursing, ancillaries, unit secretaries, lab, pharmacy, imaging, etc.).	7	4.71	0.49
28	In terms of transitioning the organization to the new system (go-live, conversion, system activation):	Electronic and physical support artifacts (user manuals, short task-specific videos, workflow summaries, etc.) should be available by go-live at every physician workstation.	7	4.71	0.49
47	In terms of supporting ongoing system assimilation and organizational transformation:	After go-live, the organization and the system will undergo a process of mutual transformation, a creative process which should be anticipated and planned for.	7	4.71	0.76
57	To promote physician adoption, the major critical success factors include:	Support ongoing system assimilation and organizational transformation.	9	4.67	0.50
15	To enhance physician adoption, project goals should include a significant percentage which are related to:	Physician and other end-user satisfaction.	9	4.67	0.50
59	In terms of establishing effective project governance & communications:	A written governance plan should be prepared which delineates and details the committees to be formed or restructured and their interrelationships, thus defining the decision-making process for the project.	9	4.67	0.50

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 2 Items with Panel Agreement

Question Number	Question		Count	Average	StDev
56	The project management group should be responsible for:	Creating and maintaining a detailed project plan.	9	4.67	0.50
81	The project management group should be responsible for:	Managing project resources.	9	4.67	0.50
88	In terms of modifying existing IT Infrastructure to support project goals and requirements:	Physicians should have single sign on technology to minimize repeated system authentication during the work day.	9	4.67	0.50
54	To promote physician adoption, the major critical success factors include:	Transition the organization to the new system.	8	4.63	0.52
64	The project management group should be responsible for:	Performing an analysis of risks and mitigation strategies for the high-profile risks.	8	4.63	0.52
84	The project management group should be responsible for:	An overall assessment of organizational readiness during the project startup phase to identify key issues that will need to be addressed in the project plan.	8	4.63	0.52
11	In terms of training users to get their work done efficiently and effectively with the system:	High-volume and high-revenue physicians should be identified early and can use the system expertly at go-live.	8	4.63	0.52
77	In terms of supporting ongoing system assimilation and organizational transformation:	Committees must remain in place indefinitely that support system maintenance and evolution over time, e.g. order set, clinical decision support, process improvement, etc.	7	4.57	0.53
36	To enhance physician adoption, project goals should include a significant percentage which are related to:	Should be specific and measurable.	9	4.56	0.53
23	Since it would be difficult or impossible to achieve organizational objectives related to the EHR otherwise, physician use of the EHR should be a required condition of continued clinical privileges.		9	4.56	0.53
82	The project management group should be responsible for:	Overseeing and coordinating with vendor project management teams.	9	4.56	0.53
33	A project management group (project management office, project management team, project management committee) led by an experienced individual should be created by the institution.		9	4.56	0.73

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 2 Items with Panel Agreement

Question Number	Question		Count	Average	StDev
30	In terms of modifying existing IT Infrastructure to support project goals and requirements:	Interfaces to existing systems should be completed, tested, and users trained on how to access these systems prior to go-live.	9	4.56	0.73
44	Regarding printers:	Placement and number should be carefully planned.	9	4.56	0.73
76	Regarding printers:	Prescription printers should be placed in secure areas and properly configured prior to go-live.	8	4.50	0.53
34	In terms of training users to get their work done efficiently and effectively with the system:	Early in implementation, separate classes in general computer skills should be offered to physicians who indicate a need for them.	8	4.50	0.53
4	To enhance physician adoption, project goals should include a significant percentage which are related to:	Patient care outcomes.	9	4.44	0.73
66	The project management group should be responsible for:	Ensuring that a detailed project charter has been developed (or creates the charter with review and approval), which delineates the project purpose, goals, requirements, scope, deliverables, resources, and timeline.	9	4.44	0.73
27	Regarding printers:	The printer naming convention should allow users to identify the location of the printer before they print.	9	4.44	0.73
62	In terms of supporting ongoing system assimilation and organizational transformation:	The data collected by and the process control implicit in the EHR should be used to drive ongoing continuous organizational improvement efforts through Lean and Six Sigma methodologies, creating a true learning organization that grows and develops over time.	7	4.43	0.53
8	Key committees relating to physician adoption that should be included in a governance plan are:	A policy committee to update or create organizational policies which will be affected by the EHR.	8	4.38	0.74

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 2 Items with Panel Agreement

Question Number	Question	Count	Average	StDev
20	A communications plan that specifies the content of messages to be delivered, the groups that should receive messages, the media for messages (newsletters, staff meetings, email, etc.), and the timing of messaging should be completed in the early, start-up phase of the project.	9	4.33	0.50
73	In terms of modifying existing IT Infrastructure to support project goals and requirements:	9	4.33	0.50
2	To promote physician adoption, the major critical success factors include:	9	4.33	0.71
72	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	8	4.25	0.71
60	Physician participation in developing a shared organizational vision, explicitly delineated expected benefits, and specific measurable goals:	9	4.11	0.60
89	To enhance physician adoption, project goals should include a significant percentage which are related to:	9	4.11	0.60
58	In terms of establishing effective project governance & communications:	9	4.11	0.78
83	Physician participation in developing a shared organizational vision, explicitly delineated expected benefits, and specific measurable goals:	9	4.11	0.93
50	Physician adoption will be fostered by discussing potential EHR benefits with the medical staff.	9	4.11	0.93

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 2 Items with Panel Agreement

Question Number	Question	Count	Average	StDev
17	Due to the complexity of the implementation process, the intensive need for resources, and the highly integrated nature of modern EHRs, at the hospital level it is usually preferable to do a “big bang” implementation, bringing the entire system up for all users at once.	9	4.11	0.93
78	In terms of establishing effective project governance & communications:	9	4.00	1.00
	Governance planning should be completed in the early, start-up phase of the project.			

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Appendix G

Round 2 Delphi Items which Failed Agreement

Question Number	Question		Count	Average	StDev
42	In terms of training users to get their work done efficiently and effectively with the system:	Training will be a long-term need as new staff arrive and new system functionalities are added.	7	4.71	1.73
61	In terms of training users to get their work done efficiently and effectively with the system:	Physician training includes system demonstrations which should begin as soon as possible after system selection at multiple venues such as staff meetings, lunch-and-learn sessions, etc.	8	4.50	1.07
10	In terms of training users to get their work done efficiently and effectively with the system:	In addition to a required amount of classroom time, physician training should include alternate opportunities such as self-learning, mentoring, and 1-on-1 sessions.	8	4.50	1.07
37	In terms of training users to get their work done efficiently and effectively with the system:	Super users should be trained early and in depth and should understand that training their colleagues is expected and will be required.	8	4.38	1.19
80	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	Physician documentation should be designed with sufficient structured sections to capture desired data and with sufficient free text sections to capture nuances of care and to maintain physician efficiency.	7	4.29	1.58
38	In terms of training users to get their work done efficiently and effectively with the system:	Formal physician training should begin in the last weeks before go-live, after the system has been completely designed and tested, and near enough to go-live that training will still be fresh in physicians' minds.	8	4.25	1.04
74	Physician participation in developing a shared organizational vision, explicitly delineated expected benefits, and specific measurable goals:	Should be sought early in the process before project requirements and scope are set.	9	4.22	1.09
67	In terms of designing the system (data structures, user interfaces, business process support, functionality, etc.) to support organizational goals, provider effectiveness, and organizational efficiency:	Network-level speech recognition should be provided to physicians who request it.	7	4.14	1.60
3	To promote physician adoption, the major critical success factors include:	Modify existing IT Infrastructure to support project goals and requirements.	9	4.11	1.05

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Round 2 Delphi Items which Failed Agreement

Question Number	Question	Count	Average	StDev
16	The organization should have a written communications plan, created and administered by a communications committee.	9	4.11	1.05
51	In terms of modifying existing IT Infrastructure to support project goals and requirements:	9	3.89	1.05
41	In terms of modifying existing IT Infrastructure to support project goals and requirements:	9	3.33	0.50

CRITICAL SUCCESS FACTORS FOR PHYSICIAN ADOPTION

Appendix H

Critical Success Factors Suggested by the Expert Panel

Answer Options	Response Count	Mean	StdDev
Workflow associated with changes	7	4.86	0.38
Understanding and addressing physician concerns and objections	7	4.86	0.38
Ensure that clinical leaders are engaged in all phases of requirements definition, system selection, and implementation.	7	4.71	0.49
Ease of use and physician productivity (and loss thereof) are primary concerns.	7	4.71	0.49
Usability of the interface	7	4.71	0.49
Active and visible support from the organization's executive leadership (e.g., CEO, CMO, CMIO)	7	4.71	0.49
Recruiting respected members of the active medical staff to serve as physician champions for the project.	7	4.71	0.49
Physician advisory group to dive into the mechanics of content and workflow; physician 'champion' in each specialty to assist with content and workflow development and adoption	7	4.57	0.53
Involving respected physicians in the project	7	4.57	0.53
Metrics are key, and should include both pre and post measurements	7	4.43	0.53
Align physician clinical leadership (as compared to MD technologists) [sic] to goals and function of system.	7	4.29	0.76
[Details of governance and communication plans must take account of] the size, geography, politics and previous history of the organization.	7	4.00	0.82
Physicians should approve the communications sent to physicians	7	3.57	0.79
A backup plan is needed for elderly physicians who seem incapable of making the transition to an EMR.	7	3.57	0.79