EVALUATION OF AN EMERGENCY DEPARTMENT
SYSTEM REPLACEMENT:
SOCIO-TECHNICAL ASSESSMENT OF A FAILED PROJECT

by

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CERTIFICATE OF APPROVAL

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This is to certify that the Master's Capstone Project of

David Keith English, M.D., F.A.C.E.P.

"EVALUATION OF AN EMERGENCY DEPARTMENT SYSTEM REPLACEMENT:
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Has been approved

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The opinions expressed in this paper are those of the author, and not those of Oregon Health & Science University (OHSU), Alameda Health System, or any prior employer of the author.

ABSTRACT

Throughout the United States health care industry, early-generation clinical systems are being rapidly replaced with integrated and certified systems, in a rush to meet "meaningful use" goals and capture federal funding. Emergency departments and other clinical areas were early adopters of specialty-specific information systems, but they are now being mandated to abandon those systems and adopt enterprise systems. Many of the enterprise systems do not have the same maturity as the departmental systems, and are not as finely adapted to ED workflow. This rapid cycle of change is driven almost entirely by enterprise financial concerns that are external to the ED, rather than by clinician dissatisfaction with the existing system.

The effect of this enormous system replacement undertaking is uncertain. It may have positive or negative effects on throughput, quality of documentation, quality of care, or patient safety. Clinicians may experience stress around the need to abandon familiar tools and processes and learn new tools and processes. There may be effects on morale, job satisfaction, and the learning environment in teaching institutions. Although much is known about the effects of initial system implementation, much less is known about the effects of imposed system replacement. In an environment of such rapid change, it is inevitable that some projects will fail.

One such project was undertaken to replace a highly-rated Emergency Department Information System (EDIS) (Wellsoft™ EDIS[1]), with a new version ED module of an enterprise Electronic Health Record (EHR) (Soarian™ Clinicals[2] version 3.3). However, the replacement project foundered and the new system was not implemented. The failed project was evaluated qualitatively using a socio-technical framework. The evaluation included surveys of implementation team members and selected other stakeholders, focused interviews with a subset of team members, and grounded theory analysis of survey and interview results. This project evaluation demonstrated that issues of institutional leadership, communication between the team and the vendor, and institutional focus were the dominant areas of failure. Despite the relative immaturity of the newer system, technical failings were not a dominant

feature of the stakeholders' assessments. Limited flexibility of product design was a significant concern, but it was entangled with the other issues.

Traditionally, clinical systems are replaced because they no longer meet the needs of the users, have been superseded by newer technology, or have become too expensive to maintain. The United States health care industry is currently experiencing a wave of system replacement motivated by other reasons. Early-generation clinical systems are being replaced with integrated and certified systems, in order to meet the goals of the HITECH[3] "meaningful use" rules and capture federal incentive funding. Emergency departments and other clinical areas that were early adopters of specialty-specific information systems are being mandated to adopt enterprise systems instead. Many of the enterprise systems do not have the same maturity as the departmental systems, and are not finely adapted to the workflow of a busy Emergency department (ED). This rapid cycle of change is driven almost entirely by enterprise financial concerns around the meaningful use program, rather than by clinician dissatisfaction or operational failings of the existing system.

Traditional recommendations for system implementation include a high level of user engagement and participation. User participation in the new wave of implementation has been secondary to the financial and integration concerns of the enterprise. In the author's institution, a few users were invited to inspect two candidate enterprise systems, but those users were informed that retention of the existing department-specific system was not an option. Exploration of other candidate systems was also not an option. Only enterprise-capable vendors with an existing footprint in the organization were eligible for consideration. The new system was selected for entirely financial reasons, even though the ED module had not yet been delivered to any customer in even a beta-test version. The risk of implementation failure was not seriously discussed during the selection process.

The effect on users of this enormous system replacement undertaking is uncertain. An enterprise system promises greater integration and availability of patient information across settings, with fewer interfaces. A new system may have positive or negative effects on patient throughput, the quality of documentation, the quality of care, or patient safety. Clinicians may experience stress around the need to abandon familiar tools and processes and learn new tools and processes, or they may be pleased with the new tools, new information, and new features

of the new system. The system replacement may have unforeseen effects on provider morale, job satisfaction, and the learning environment in a teaching institution. Although much is known about the effects of initial system implementation, much less is known about the effects of imposed system replacement. There have been reports of system implementation failure, but few on the failure of system replacement projects.

Rice University[4] published its experience in replacing a student information system. The project was necessitated by the approach of the year 2000[5], but the older system was otherwise satisfactory and could have been simply replaced without significant process changes. Senior management foresaw increasing stress on the business processes of the organization, and used the opportunity to extensively re-engineer those processes influenced by the system. Because of the dramatic process change effort, user engagement was very high throughout the project and the results were very positive for the organization. The organization learned new ways of managing its data and workflows, as well as lessons in effective communication and the management of user expectations.

Komperud[6] wrote about his personal experiences with replacement of pension administration systems. Among his list of "top ten" risks to a project were ineffective executive support, and key staff turnover, both to be discussed further in the project under consideration here. Schedule flaws were highlighted as a serious risk, with the admonition to "Plan for an on-time completion, but budget for a 20% schedule slippage." Scope creep during the project and unrealistic expectations of the product were also highlighted as particular risks.

Clark[7] presented a schema for planning for system replacement, but it focused on technical obsolescence of equipment as the driver for the system replacement. He advocated an evolving inventory database of equipment with a projected lifecycle for each item. He further suggested a scheme for prioritizing items, and posited that some equipment or systems need not be replaced because of changing needs or clinical practices. His focus on hardware is of limited relevance to the replacement of complex software systems, which tend to evolve over time with modules, interfaces, enhancements, service packs and patches.

Sikkel[8] described planning for a system replacement in a medical center as an academic exercise for a graduate level informatics class. Although the author was critical of classroom exercises as inadequate preparation for real-world work, he describes how student contact with the target healthcare organization was carefully constrained to avoid "burdening" the organization. The problem posed to the students is very plausible and relevant. "The supplier of the hospital information system (HIS) has been overtaken and the new supplier will end the service contract. A new HIS has to be installed and to be integrated with more than a dozen heterogeneous peripheral systems." Teams of students are assigned to make a recommendation and project plan for the organization. Although the author is enthusiastic about the lesson, he does not provide information about the outcome in a real-world environment, nor about the recommendations made by his teams of students. There is no suggestion that the student plans are routed back to the target organization, and he does not report any of the resulting student work.

Lapointe and Rivard[9] described a series of three case studies suggesting that physician acceptance or resistance of the project was the key factor in project success or failure. They focus on "resistance behaviors" within the medical staff that may arise when a combination of pre-existing social factors and "perceived threats" from the implementation come together within an organization. They describe successful and unsuccessful attempts to manage the physician behavior from outside the medical staff. In their schema, collaboration with the physicians and improvements to the information system both play relatively small roles in alleviating the resistance behavior, whereas managerial manipulation is given a greater role.

Paré and colleagues[10] performed a Delphi survey in Quebec, Canada, where the provincial government had invested heavily in the roll-out of information technology to a variety of healthcare settings. The survey rated the involvement of a physician champion as the single most important predictor of success, though that has not emerged as a major concern in much of the other literature. "Lack of commitment of upper management" was the second most important factor, and apparent usefulness of the system was third. This group of experts emphasized that technical failings of the system were generally not a major factor, though poor alignment between the information system and the clinical workflow was significant.

Taklan and colleagues[11] described the implementation of an EHR in a mental health facility in the United Kingdom. Although a successful implementation from a strictly technical perspective, user engagement and user acceptance was poor, leading the authors to title their article in part "We are bitter, but we are better off." The implementation was one part of a large and prolonged government project to modernize healthcare IT throughout the United Kingdom. The software was seen as obsolete and inflexible by users, and the process for implementation was very rigid and bureaucratic. This severely limited any opportunity to customize the software. Social and technical change within the organization was intense around the implementation and shortly thereafter, but ultimately the authors concluded that quality of care did improve despite the difficulties.

Aarts and colleagues[12] have published multiple articles on the unsuccessful effort to implement CPOE in a large Dutch teaching hospital. He argues that success or failure is a social determination much more than a strictly technical one, and that the project and the social environment mutually shape each other. In a later work based on the same project, Peute and Arts[13] describe in detail a socio-technical framework for evaluating the failed project. Their work revealed a number of important themes which helped to shape the current project, including trust, collaboration, communication, involvement, resource allocation, and understanding of workflow. In their model, incomplete understanding of the clinical workflow was the most important factor in the failure of the project, but pressure from other organizational and social issues prevented development of a full understanding of the workflow. In a particularly informative error, they describe how the development process was done in narrow departmental silos, preventing a comprehensive sense of the user interface and workflow. The perceived value of the project to clinicians was limited, because paper processes had been highly optimized for efficiency and the information system had not incorporated those optimizations. They also noted a lack of feedback to engaged users about the system development process, and argued that lack of two-way communication became a significant hazard to the project.

Gettinger and Csatari[14] wrote about the Dartmouth-Hitchcock system replacement project, in which an internally-developed system was replaced with an unspecified commercial EHR. The legacy system had no CPOE component and lacked numerous other desirable features, while

the cost to maintain it had grown very large. The effort required to qualify it for HITECH meaningful use incentives was too large for the organization to consider. The legacy system had evolved over two decades and had a large user base and extremely large data store. The replacement EHR vendor counseled against efforts to convert data from the older system, even arguing for manual input of key data as the primary conversion process. The project team insisted on conversion of key data elements, but they were not entirely prepared for the difficulties that ensued. They document in some specificity the intensive efforts to convert various types of data, and describe surprising success at converting allergy data. Medication reconciliation presented special problems (45% of existing orders failed to convert) because of duplicate entries, non-standardized prescription terms, and differences in the way that the two systems presented lists of medication. The overall effort was judged as successful, but the perspective of the paper is almost entirely technical in nature. Nothing is presented regarding patient flow, provider workflow, user satisfaction or engagement, or any other social aspect of the project. The authors state that they did not identify any "substantial negative outcomes to patients" related to the system transition, but do not provide details on any lesser outcomes.

This project was originally planned as a mixed-methods before-and-after serial evaluation of a system replacement project. A highly-rated[15] and well-liked ED-specific system was to be replaced with a new ED module of a larger enterprise system. The new EDIS was scheduled to go live first in November 2012 and then postponed until February 2013. However, the underlying system replacement project encountered increasing difficulties throughout the second half of 2012. System response time and stability were not satisfactory, and the vendor was unable to identify a clear cause. Common tasks would often end in significant error messages and loss of data[i]. Patches and service packs were issued with increasing frequency, but system stability was not improved. So much time and effort was devoted to attempts at error mitigation that important functions of the system (such as the ability to record professional fees and facility charges) were neglected in the build process. A summit meeting was held in late December 2012 between the project team, the executive team, and executive

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[i] One particularly frustrating error occurred at the time of saving a long clinical document. The error message stated that the document template was defective, and instructed the user to discard the document (losing all the work to that point), choose a different template, and re-enter all the information. This was eventually traced to a failure to successfully add new data elements to the database schema when installing new documentation templates, but this also could not be rectified in time for the scheduled go-live.

representatives of the vendor. After a determination that the issues could not be remediated in time to train staff before the planned go-live date, the EDIS project was officially placed "on hold." Project resources were re-directed to an urgent effort to interface the legacy EDIS with the new inpatient EHR. The author then undertook an alternate evaluation of the factors leading to this project failure.

Alameda Health System (AHS), until recently known as Alameda County Medical Center (ACMC), is a California safety-net health system with some characteristics of an Integrated Delivery Network. It provides both inpatient and outpatient care to an underinsured, ethnically diverse population of patients requiring interpreters in over two-dozen languages. It is licensed for up to 475 inpatient beds on three campuses (including a large Skilled Nursing Facility (SNF)) though the census is generally lower because many fewer beds are staffed. The campuses include a comprehensive inpatient medical-surgical hospital with a Level II Trauma Center. This hospital provides care for over 11,000 patient admissions each year, 95% of them admitted through the Emergency Department. The ED is the busiest in the area with almost 90,000 visits annually. The system also has a freestanding psychiatric hospital, and a rehabilitation hospital which shares an aging campus with the SNF.

Outpatient services are provided at all three hospital campuses. ACMC also has three freestanding outpatient health centers with over 200 providers in both primary and specialty care. These centers provide over 280,000 outpatient visits annually. ACMC is a teaching facility with residencies in Emergency Medicine, Internal Medicine, General Surgery, Orthopedics, Ophthalmology, and Oral Surgery. ACMC has a loose alliance with a consortium of independent and charitable clinics serving a similar patient population; these clinics refer patients for specialty care to ACMC. The consortium decided to implement the NextGen Ambulatory EHR[16], and ACMC has held talks with the consortium about aligning into an Accountable Care Organization[17]. ACMC leadership believes that having ACMC clinics and the consortium on the same platform may offer synergy and ease of data sharing. ACMC is also engaged in an effort to partner with (or purchase) other area healthcare facilities in order to prosper under the Affordable Care Act[18]. This effort requires an EHR platform that is extensible across a growing enterprise.

Before 2012, ACMC had major gaps in its clinical information systems, with no EHR in its clinics or inpatient facilities, and CPOE and physician charting only in the ED (using the best-of-breed Wellsoft™ product). Siemens supplied the core financial (on the now-deprecated

Invision[19] platform), laboratory (Novius[20]) and radiology (Syngo.via[21]) systems at the acute hospital, and McKesson Horizon[22] provided a nursing documentation system on the same campus. Numerous special-purpose and departmental systems were in use with very uneven integration. The main hospital would have been classified as a stage 3 in the HIMSS Analytics scale[23], and the other campuses would have scored even lower if considered separately. All physician documentation outside the ED was either handwritten or dictated, and e-prescribing was likewise unknown outside the ED.

As part of a system transformation effort, and in anticipation of qualifying under the Affordable Care Act Meaningful Use[24] incentives, a new Chief Information Officer (CIO) was hired in April 2010. He expressed a very strong preference in favor of an enterprise single-vendor strategy wherever technically possible. He consistently expressed distaste for the effort required to interface systems from disparate vendors. He arranged a bidding competition between Siemens and McKesson for a long-term, comprehensive relationship. After an intensive negotiation, ACMC committed to a strategic alliance with Siemens Medical Systems in summer 2010. The agreement included upgrades to bring existing systems to current product lines (Soarian™ or equivalent), and a commitment from Siemens to implement all systems needed to qualify for Meaningful Use funding. Because Siemens did not have an ambulatory EHR product at that time, the contract included the Siemens strategic partner NextGen™ as the ambulatory EHR.

The CIO and Chief Medical Information Officer (CMIO) adopted a fairly aggressive posture towards implementation, and worked to negotiate a Development Partner relationship with Siemens. This relationship committed ACMC to early adoption of the then pre-release Soarian 3.3 platform at all of the acute-care facilities and the ED. Although previous versions of Soarian had been focused almost entirely on inpatient care, Soarian 3.3 was scheduled to include an extensively revised and expanded EDIS module with a new structured template physician documentation system (commonly referred to as "p-doc"). This was the largest and most concentrated Information technology (IT) initiative ever undertaken at ACMC, and due to the constraints of the federal funding program it had the most immutable deadlines by far.

The Soarian inpatient EHR was scheduled for the psychiatric and rehabilitation units to occur in mid-2012, with the acute hospital and ED scheduled to go live in fall 2012. Simultaneously, the NextGen ambulatory EHR was rolled out to the three outpatient health centers beginning in late 2011 and completing in mid-2012. NextGen for the ambulatory clinics at the hospital sites was planned for 2013. Various issues of configuration, performance, and training caused the psychiatry and rehabilitation facilities to delay their Soarian go-live until November 2012. That pushed the acute care hospital and ED Soarian go-live back to February 2013.

A mixed-methods qualitative and quantitative evaluation of the system replacement in the ED was planned, and a project design was approved by the ACMC IRB. That study design has been reviewed in detail elsewhere[25].

In August 2012, during the run-up to the first attempted Soarian go-live, the CIO announced his departure for another organization. The office was vacant from mid-September to early November, when an interim CIO from a consulting firm was appointed. Build and configuration of the Soarian EDIS continued throughout the fall of 2012, but substantial performance issues persisted and integration testing was repeatedly unsuccessful. As training time rapidly approached, in mid-December a summit meeting was called between the vendor, the implementation team, and the ACMC executive team. The existing problems were reviewed, and no rapid pathway to resolution of the key problems could be identified. A decision was made by the interim CIO to halt work on the Soarian EDIS module and retain the Wellsoft product for the foreseeable future. All available resources were pulled from the Soarian EDIS project and re-deployed to a crash effort to interface the Soarian inpatient EHR with the Wellsoft EDIS. The inpatient portion of the Soarian EHR went live in the acute hospital in February 2013. In March 2013 the interim CIO left the organization, and in April work on the Soarian EDIS resumed under a new interim CIO.

Numerous workflow issues in the ED have been identified since the inpatient EHR go-live, related to the use of two disparate systems for patient care. Testing of the interfaces between the Wellsoft EDIS and the Soarian EHR was of necessity limited, and multiple errors and omissions surfaced in the days after Soarian activation. Inconsistent application of business rules, and last-minute adjustments to workflows in Soarian caused further interface failures.

Initial plans had called for a sharp transition between the two clinical systems at the time inpatient admission orders were placed into the Soarian system. However, inpatient throughput substantially decreased after activation, and boarding times in the ED for admitted patients became extraordinary. Deficiencies in the Soarian training of ED staff and in the integration of the two systems became apparent. Additional crash efforts to improve integration were undertaken, and rolling training efforts for ED nurses to better understand and use the inpatient system were instituted. These problems and mitigation efforts have led to increased pressure to deploy the delayed Soarian EDIS, while at the same time draining resources needed for that project.

Consultants and agency staff were heavily used in the system development and training efforts, and overtime and temporary employees were brought in to backfill clinical duties during training sessions. Staffing throughout the hospital was maximized during the Soarian inpatient go-live. The implementation delays led to extensive cost overruns as consultant contracts were extended. Because of patient flow delays after the inpatient go-live, nurse staffing was increased even beyond the normal maximum throughout the acute hospital. Overtime costs were large. The ED alone incurred an estimated overtime nursing cost of $36,000 attributable to the inpatient go-live[26], even after contracts for temporary staff for the EDIS go-live were cancelled. This occurred in the context of delayed and declining reimbursement from the organization's usual funding sources (in part attributed to pending Affordable Care Act changes, and in part due to various budget pressures on the state and local governments). Consultants were rapidly dismissed after the inpatient go-live, though many issues with the inpatient EHR remain unaddressed. At a governance meeting two months after the go-live, more than 2900 open tickets and issued were presented for prioritization. Prescriptions could not yet be printed from within the EHR for patient discharge, promised integration with the PACS and ECG systems had not yet appeared, and rounds reports could not be printed in a usable format. Occasional medication orders still caused the application to exit, though most such had been repaired.

Design: Retrospective mixed-methods, descriptive[27].

Setting: Emergency Department of an urban public hospital trauma center (90,000 visits per year) with residency programs

Subjects: All ACMC staff and consultants who participated in the failed Soarian EDIS system implementation project of 2012, or executives who participated in the decision to halt the project, were initially considered for participation. Vendor representatives who participated in the implementation effort were also identified.

Exclusions: Participants who left the project before the 4th quarter of 2012, or who could no longer be reached were excluded. One participant who was dismissed for cause was also excluded. Any subject was free to self-exclude. Subjects who were distressed by the study or unwilling to participate were free to withdraw at any time without penalty. All but one of the vendor representatives declined to participate.

Sampling: All willing subjects (the entire population) were invited to participate in the primary survey described below. Completion or non-completion of the survey was tracked individually. This allowed for issuance of reminders, and rewards for completion. Results are reported in aggregate only, since participants were promised confidentiality.

Survey participants were invited to participate in a subsequent interview. All the volunteers were selected for a single semi-structured interview of 15-20 minutes duration. The interviews were recorded if the subject gave verbal consent. Completion of the interview was tracked for issuance of rewards, but all participants were promised confidentiality.

Measurements[ii]:

Survey. The author developed a list of statements about various aspects of the ED information system and the implementation project. These topics were based in part on a pilot survey developed for the initial system evaluation project. The survey was expanded to include the themes developed in the model of Peute and Arts[28]. Final topics included system satisfaction, usability, and fitness for purpose. Statements also covered adequacy of project resources, communication and trust, and issues of leadership. Social questions focused on perceptions of the project and the decision to stop the project. Statements were drawn from a variety of published assessments, including assessments of user interface satisfaction[29,30], and from a commercial library of user satisfaction questions offered by the survey distribution website SurveyMonkey[31].

Most statements were presented with a 5-point judgment scale, from 1 – Not at all, 2 – Slightly, through 3 – Moderately, 4 – Very, to 5 – Extremely. Each question was presented with an opportunity to provide free text feedback in addition to the scale response. Except for the consent, no question was mandatory. Participants were then asked to rank order the importance of the key principles used to drive the preceding questions. Finally, all survey participants were asked to indicate their willingness to undergo a brief interview. The survey questions are reproduced in Appendix A.

Interview. All willing participants were interviewed in a semi-structured narrative fashion[32] no later than one week after completion of the survey. Interviewees were offered a token reward for their participation. Interviews focused on socio-technical aspects of the system replacement project[33] with attention to themes developed in the survey and the survey responses. Interviews were recorded if the subject agreed. Detailed notes were transcribed at the time of interview, then further completed by review of the recordings. Transcripts were coded and grouped in a method similar to grounded theory. Because of the small number of

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[ii] The original project plan for evaluation of the successful project would have included the collection of department productivity statistics as an objective measure of impact on patient flow in the ED. However, since the ED system did not change as planned, and the ED was severely affected by general hospital-wide issues, these statistics were judged no longer relevant to the evaluation.

interviews, grouping was done by hand. Themes were developed to explain the users'
experiences.

Data Analysis: Because the survey data is primarily descriptive and the number of
respondents is necessarily low, mode or categorical information on each major topic is
presented. Simple graphical representation of selected answer sets will illustrate trends.

Transcripts of interviews were coded and grouped in a method similar to grounded theory.
Statements were grouped by theme. Themes were further developed and expanded with
comments from the transcripts to explain the users' concerns and experiences.

Response

Eighteen of twenty-nine individuals completed all or a substantial part of the survey. Nine survey respondents from various parts of the ACMC project team and executive team agreed to be interviewed. All nine were successfully contacted and interviewed. All vendor representatives declined to complete the survey instrument, citing unspecified concerns with "compliance." One vendor representative, a physician-executive, did agree to an informal interview. That interview was not recorded but otherwise followed the same outline as other interviews, for a total of ten interviews.

Surveys

Users consistently rated a successful EDIS as extremely or very important, both generally and in relation to their own job satisfaction at ACMC. That is not surprising, given that most of the survey respondents were directly involved with the EDIS project, and all were to some degree involved in the overall EHR project.
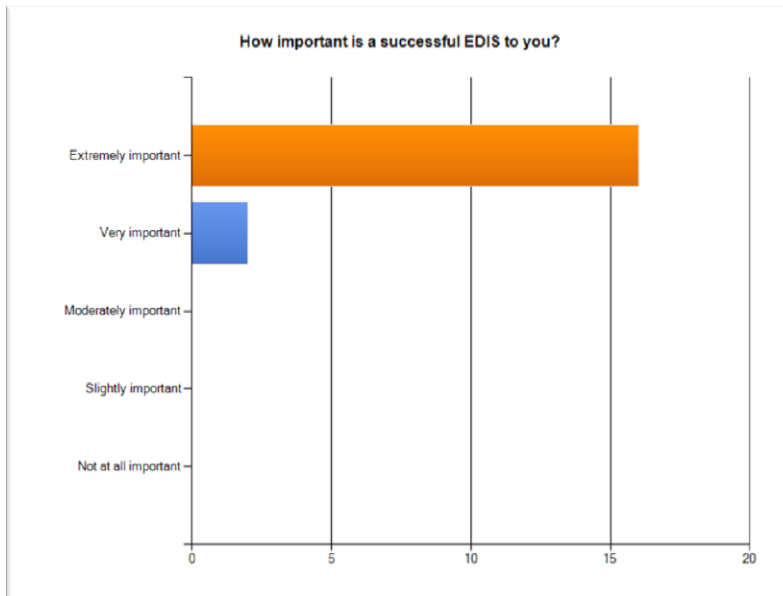

Figure 1 - Importance of EDIS Success

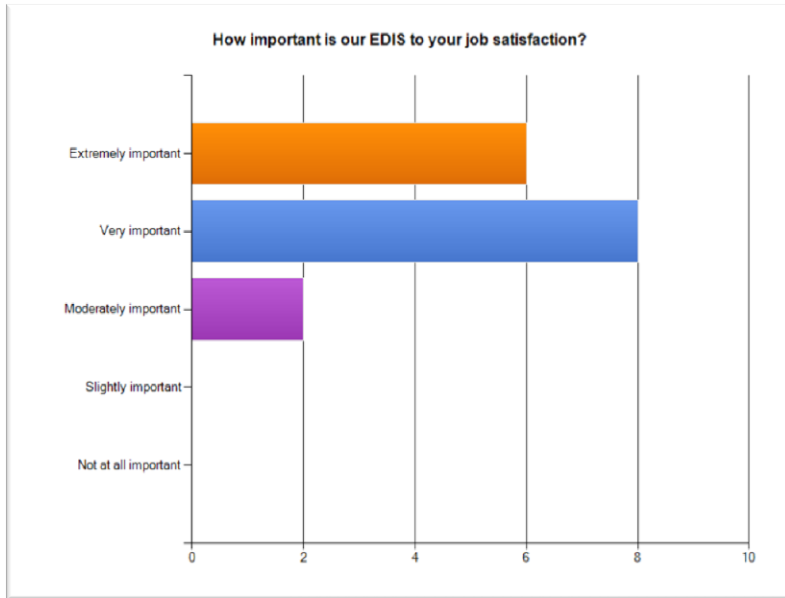How important is our EDIS to your job satisfaction?

Figure 2 - EDIS Importance to Job Satisfaction

Survey results showed a high degree of satisfaction with the incumbent Wellsoft EDIS product (80% rating it extremely or very successful), and a lesser degree of satisfaction with the Soarian EDIS (60% choosing "moderately successful" for its predicted future success).

No participants rated the ACMC organization as "extremely ready" or "very ready" for this project, though technical readiness scored slightly higher with two respondents choosing "very ready". The low organizational readiness rating was not a result of any general dissatisfaction with ACMC, since most participants (72%) indicated that they like ACMC either moderately or a great deal; none expressed dislike. By comparison, the vendor received a predominantly neutral rating, with 56% choosing "neither like nor dislike," 33% gave a positive rating, and 11% a negative rating.
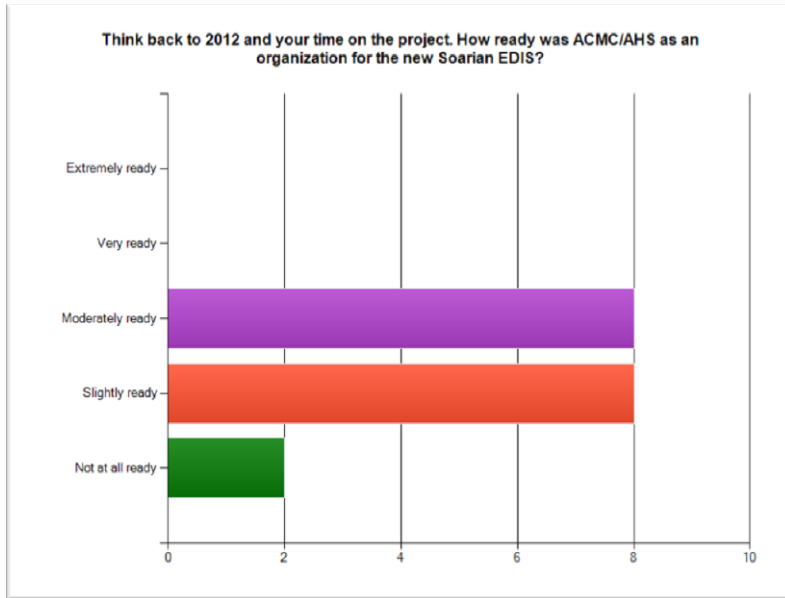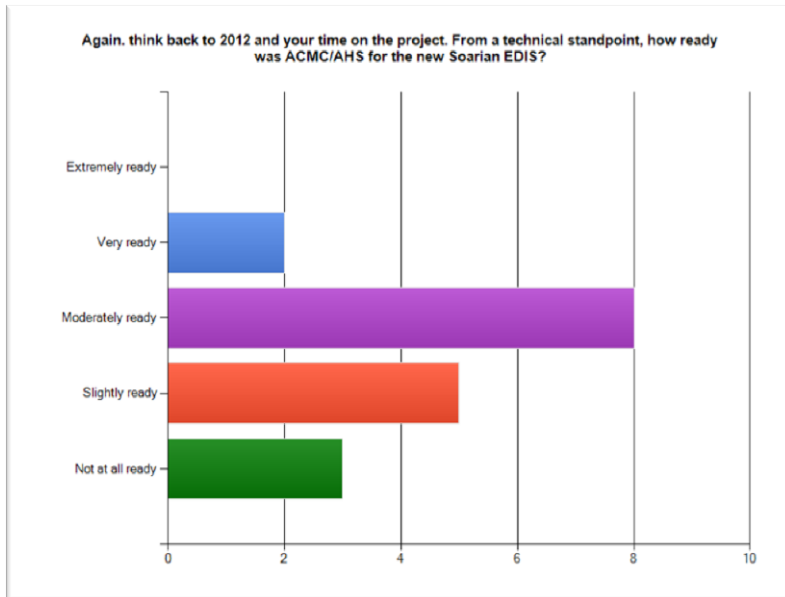
Figure 3 - Organizational Readiness

Figure 4 - Technical Readiness

Both communication between ACMC and the vendor, and trust between ACMC and the vendor received low scores.
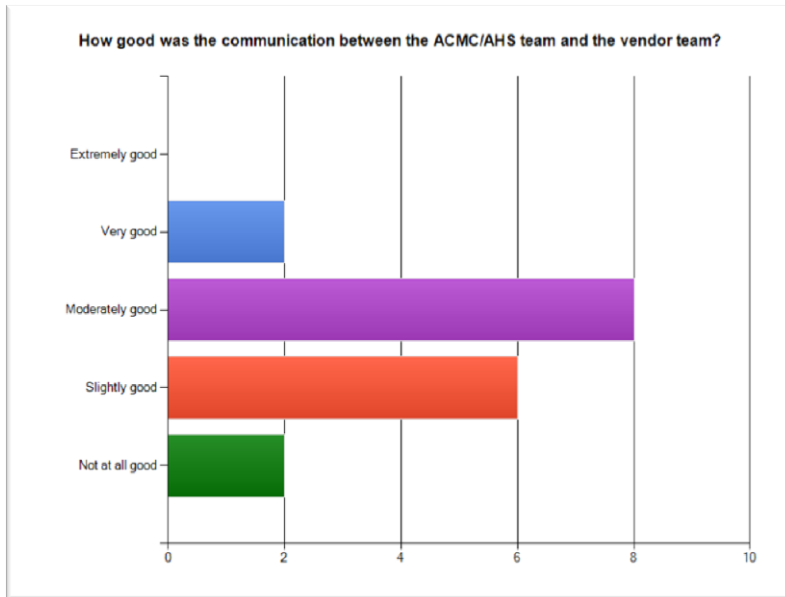

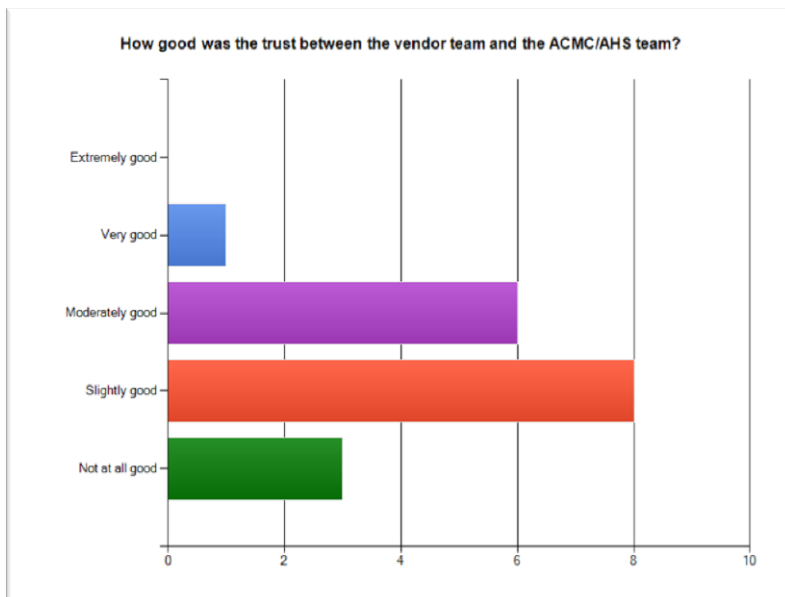Figure 5 - Customer-Vendor Communication

Figure 6 - Customer-Vendor Trust

Users were moderately satisfied with the involvement of key personnel at ACMC, 67% choosing moderately or extremely satisfied). Respondents were less satisfied with the involvement of key vendor personnel, with 50% choosing moderately dissatisfied or extremely dissatisfied. A representative comment was "I don't think the appropriate Siemens personnel took the ACMC/AHS challenges of implementation seriously enough to appreciate the ED portion of the project was at risk of not being implemented."

There was only moderate satisfaction with the internal resources devoted to the project, but even less satisfaction with vendor resources.
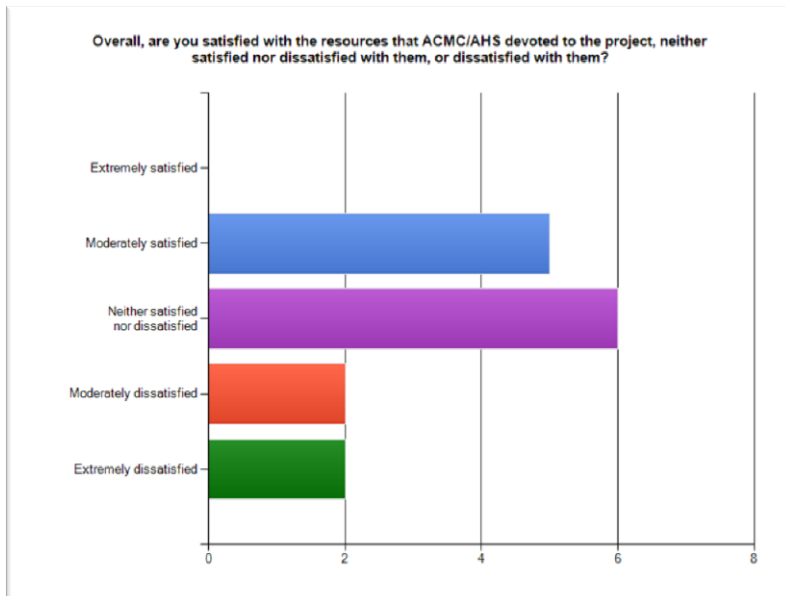

Figure 7 - Internal Resources

Overall, are you satisfied with the resources that Siemens devoted to the project, neither satisfied nor dissatisfied with them, or dissatisfied with them?
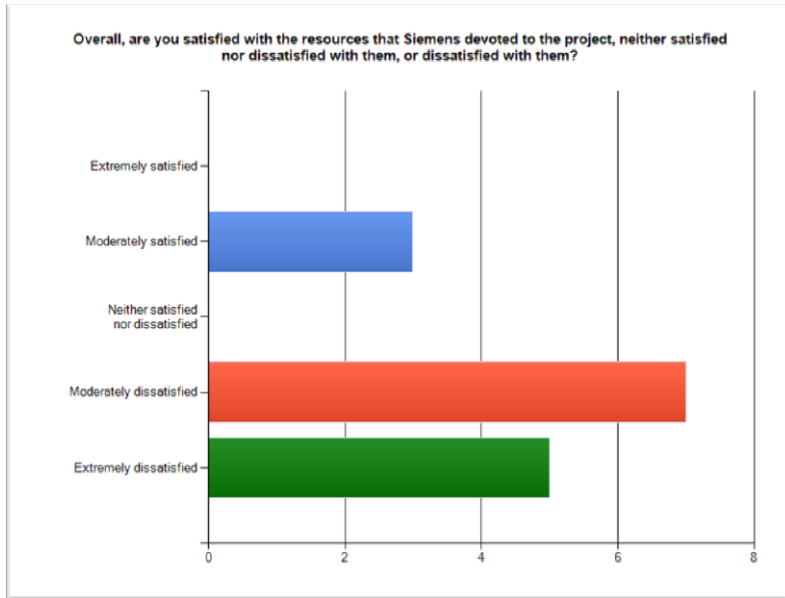
Figure 8 - Vendor Resources

Leadership at Siemens was judged as very poorly responsive to the project, and ACMC leadership was judged as only moderately responsive. "I think Siemens management could have put more focus on the development team to fix the bigger issues that were presented early on in the project, but overlooked or not acknowledged as the critical issues they were."

There was a marked disparity in understanding of clinical workflows between the ACMC team and the vendor team. The project team was believed to have moderate or very good understanding of clinical workflows by 79% of respondents. The vendor was rated very low on this question, with 85% judging their understanding of clinical workflow as slightly or not at all good. Both survey comments and interview responses reiterated this theme. One survey respondent said "It seemed as if every time we asked for something to be changed to fit our flow we were told they could not do it and this is how your flow should be."

Ranking

Survey respondents were asked to rank the relative importance of major themes. The survey instrument did not allow the assignment of the same rank to multiple items. Of note, each theme was ranked first or second by at least one user, suggesting a relatively low level of

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agreement. Graphical analysis suggested three broad groupings, with "Collaboration and trust within the team" and "Involvement level of key personnel" as the most important, and "Workflow complexity" as least important. Other themes were rated in the middle of the range.
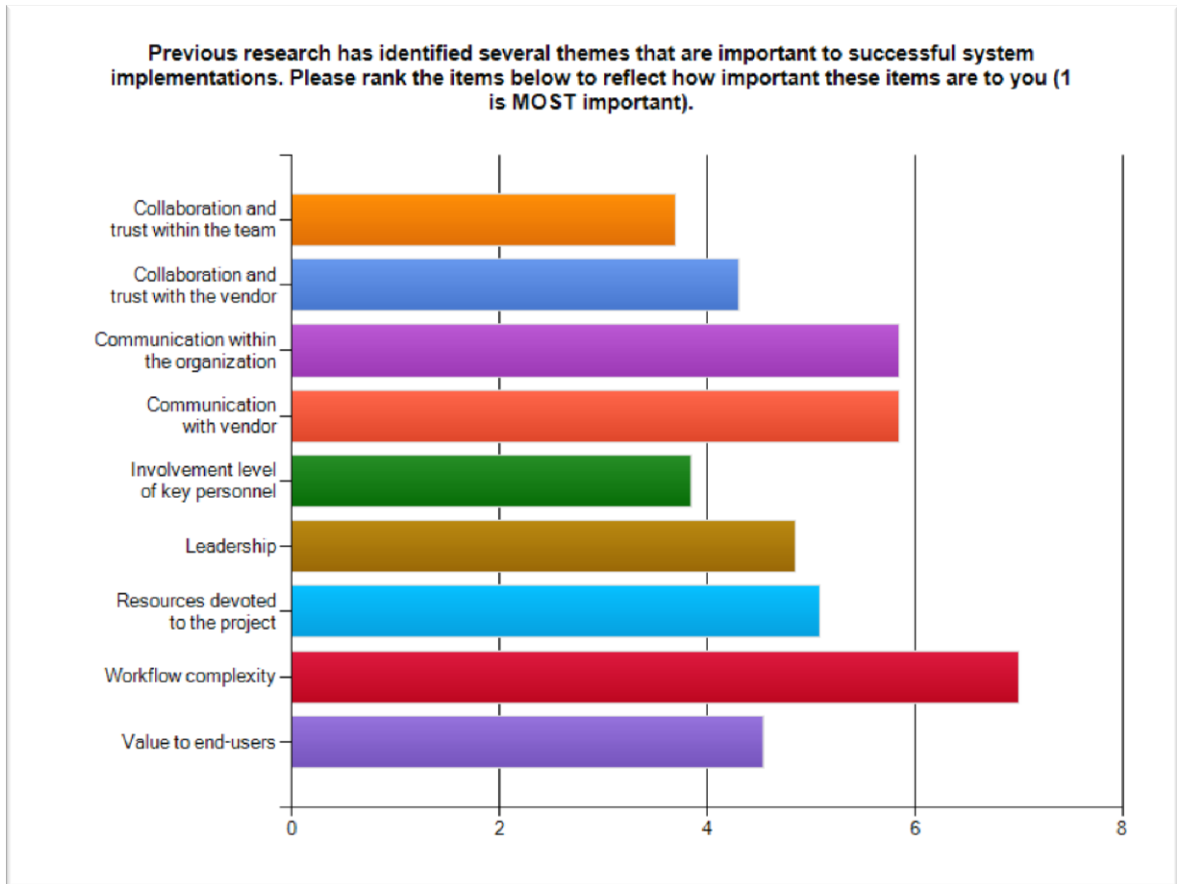

Figure 9 - Mean Ranks of Themes

Interviews

Interviews were lightly structured. Each began with a request to think back to the time working on the project in 2012, and asked "what went right and what went wrong" with the EDIS project. Although the order of questions varied based on initial responses, all interviews touched on readiness, leadership, communication, and trust. Each ended with another open-ended opportunity to express any thoughts at all about the project.

Interviews provided a substantially different perspective on the project when compared with the survey questions. Resources allocated to the project were scored as only a medium priority on the rankings, and survey respondents indicated moderate degrees of satisfaction with the resources allocated. However, every single interviewee (ten of ten) commented on resource allocation to some degree. Several described the EDIS project as a "tag-along" or afterthought to the larger project. Others acknowledged that resources are scarce in the public hospital environment, but still felt that the ED project should have been handled as a separate large project of its own. Several noted turnover of human resources (changing of contracted consultants during the active build) as an additional serious problem. By contrast, vendor allocation of resources was mentioned in only 3 of ten interviews.

Internal ACMC leadership did not emerge as a serious concern in the survey, but it was substantially mentioned in eight of the ten interviews. Leadership changes at the CIO level were a particular concern to two members of the executive group, with associated changes in strategy which disrupted the work of the implementation team. Others noted inconsistent messaging from leadership to both the team and the user base, and an apparent reluctance to intervene before the project was too far along to salvage. Although internal communication at ACMC was mentioned six times, most of the comments related to communication between leadership and users, or between leadership and the project team. Only two subjects described poor communication between members of the project team. The same two users described issues of poor collaboration and apparent rivalry within the project team, which appeared to be intermingled with the communication concerns.

Involvement of key vendor personnel, and difficulties aligning the product and clinical workflow, were each mentioned seven times. These two problems appeared to be closely related to each other and to communication by the vendor (mentioned five times). One experienced IT analyst described the vendor as "very siloed," and several subjects described great difficulty in getting issues and concerns to the right individuals. Workflow issues were presented to the vendor, but little or no response was received other than a growing "issues list." It seemed that the issues were not passed on to the individuals with the knowledge or authority to provide an answer. Several interviewees described meetings and calls with the vendor, which were unproductive because the "right people were never available." It was not

clear in many cases whether the ACMC workflow needed to change to adapt to the product, or the product could in fact be adapted to desired customer workflow. Even when the product was being changed to meet customer needs, it was difficult to learn about the vendor's plan to make those changes.

Issues of trust and collaboration were rarely mentioned, each receiving only two comments in ten interviews. The technical adequacy of the Soarian product was raised on four occasions, but only two users had serious concerns that it could not meet the basic needs of the ED. One of those users had a very specific concern about billing that had not been addressed, and the other was a manager not involved in the day-to-day project work.

The ostensible reason for halting the EDIS implementation was the technical failings reported to the summit meeting in December 2012. However, most of the technical issues identified were not inherent in the product. Most key functions were known to work in the vendor's test system, and had been used successfully at the vendor's beta test partner. Instead, these issues at ACMC represented accumulated errors and omissions in the installation and configuration of the test environment, which were beyond the ability of the local project team to diagnose and remediate. Efforts to get assistance from the vendor had been unsuccessful up to that point. Those few major issues which had no apparent technical solution or workaround in the product had been extensively reviewed by the project team, and were the subject of innumerable discussions with various vendor representatives. As these discussions had no satisfactory result, remediation plans were in place even before the decision to halt the implementation. These plans would have necessitated substantial changes in front end registration processes, but were regarded as workable.

It would be easy, but ultimately insufficient and unsatisfying, to blame the project failure on the vendor. The EDIS product was new and incompletely documented, and it continued to evolve with updates throughout the project. The pool of experienced personnel within the vendor organization was small, barely more than the internal development team. The vendor expressed a strong need to keep the development team focused on development rather than customer support. The vendor had a long track record of implementations in which the customer was expected to do most of the system configuration, with the help of vendor-supplied "implementation consultants." The skills of the implementation consultants were primarily in project management, and did not involve any deep knowledge of the product or its configuration. This methodology had been fairly successful with the more mature and better-documented inpatient EHR. It did not account for the knowledge gaps around the new and untried product.

Although survey and interview responses gave only moderate weight to communication as a cause of the project breakdown, it appears to have been a common enough failing to have severely affected the project. Early in the project, the CIO was the primary driver of "vendor

relationship management" (his term), and the person with most ready access to high level management within the vendor organization. He had the influence and power to force the vendor to bring forth the development team resources when needed. Other project team members had difficulty persuading the vendor representatives that the project was at risk, had difficulty identifying the vendor resources that were needed, and had difficulty understanding the vendor's responses. The CIO announced his departure at about the same time that significant problems in the project became readily apparent, and no one in the local organization had the skills or connections to step in to his unofficial role.

The vendor organization had its own difficulties with communication. Many meetings and calls ended in frustration, because some particular individual had not been invited to that particular meeting. Meetings were scheduled and rescheduled and little resolution was achieved. Issues were added to lists, but the items were never closed. Much time and effort was devoted to discussing which items belonged in which ticketing system or queue, and debating whether identified problems were defects or not. No one individual was able to speak on behalf of the vendor, and no one with authority in the vendor organization was able to advocate for the project.

This study did not reveal any particular concern about user engagement. User enthusiasm for the system replacement was not high in the ED, but key personnel clearly understood the enterprise perspective and need for a unified system. Involvement of key ED personnel in IT issues at ACMC, including a physician champion and a nurse champion, was already very high and remained so for the duration of the project. That involvement may reflect the relatively mature development of the existing EDIS and a high degree of comfort with clinical information systems in the ED. It may also reflect to some degree a defensive political posture, attempting to protect the benefits of the ED's highly-optimized incumbent system. There was widespread concern within the ED medical and nursing staff that a high-functioning system would be removed and replaced with a much less capable system. Staff expressed a strong tendency to rally around the incumbent system and to repeatedly question the enterprise decision to impose an unfamiliar system. The decision to delay the new EDIS was applauded by many clinical staff not associated with the project team. Despite that expressed sentiment, there was no discernible "physician resistance behavior"[34].

The size and scope of the EDIS project was widely believed to have been underestimated. Commonly expressed sentiment was that the ED project should have been handled as its own project, rather than as one part of the acute hospital implementation. There was a pervasive sense that the EDIS replacement project was much more demanding than first realized, and that it needed the resources of a full project. Even the lone vendor representative expressed concern that the ED project had been treated as a "tag-along" to another project. A separate charter and leadership parity for this project might have mitigated some of the problems with vendor communication. It is also possible that the inherent resource constraints in the public hospital environment, and the lack of high-level connection with the vendor would have dominated, leading to the same unfortunate result.

Participants at all levels expressed some concern over the organization's readiness for this project. However, concerns over social and organizational readiness were thoroughly entangled with concerns over the resources allotted to the project. Leadership commitment[35] was called into question during the interview sessions, but that was primarily a manifestation of the interim CIO and his differences in style and strategy compared with his predecessor. The organization's official position on the EHR project did not change at any point, despite numerous tactical adjustments to timelines and order of system deployment.

Business process re-engineering as a means of maximizing engagement and enthusiasm (as suggested in the Rice University[36] paper) deserves special discussion. With a combination of special services (such as Trauma), a very high volume, and active educational programs at several levels, the ED already has very complex business processes. The ED has a number of ongoing process improvement projects that involve frequent experimentation with clinical workflows. The staff has become used to a highly flexible EDIS product that could be quickly adapted to any process, no matter how transitory or arcane. With almost a decade of experience with the incumbent product, the expectation is ingrained that the EDIS will adapt to the workflow, and the workflow need not adapt to the EDIS. In this project, much effort was spent trying to adapt the product to the existing workflow, with very little to show for the effort. Little attention was paid to workflow changes that might have functioned better with the product. Both the project team and the vendor bear responsibility for that failure of communication.

There was moderate concern over the technical readiness of this relatively new and little-tested product for this particularly complex work environment. As previously noted, the product was found to be reasonably stable and functional at other test sites in near-default configuration. Although the ACMC team was judged to have a good understanding of its workflows, it was not successful at conveying that understanding to vendor representatives. Neither the local project team nor the vendor team were able to focus on the overall goals of patient care, and to suggest alternate workflows that might have worked better with the newer software. Communication with the vendor was commonly judged as inadequate. Poor communication caused inadequate collaboration and low trust. These all interfered with the efforts to resolve workflow issues. The vendor was perceived as unresponsive to customer concerns. However, the majority of the most-responsive communication had occurred at the highest levels of leadership, and this was short-circuited by the leadership change at ACMC.

Leadership change in IT was an explicit concern of only a few stakeholders in the interviews, but those remaining executives closest to the office of the CIO rated this as extremely important. The prior CIO was judged as much more engaged in the project, and much better at managing the vendor relationship. He had the vision to drive the single-vendor implementation across the enterprise, and he had robust high-level contacts within the vendor organization. His departure just before the planned go-live was more disruptive than was generally acknowledged. The interim CIO had no investment in the project, had no relationship with the vendor, and expressed a radically different strategic vision. At the time when the most critical issues needed urgent resolution, the lines of communication were disrupted.

CONCLUSION

The attempted replacement of a familiar clinical system is a socially and technically stressful event. The stress may or may not be aggravated by exclusion of the user base from the selection and implementation process. User engagement is one of the generally accepted principles of system implementation. However, the business pressure to unite enterprises under a single system is intense. This particular project failed despite a high level of user engagement. It foundered on poor communication from both the vendor and the customer. The difficulty of implementing a new system in this complex environment was severely underestimated. The replacement of an entrenched system may be a much more substantial project than an initial implementation.

This project had a loss of key leadership at a critical juncture. The leadership change greatly amplified other issues and failings in the project, particularly issues of communication with the vendor team. It is plausible that a stable leadership could have mitigated many of the problems that emerged during this project. While leadership transitions cannot always be avoided, they are a substantial risk for any large project and deserve significant mitigation effort.

CONSENT

INFORMATION AND CONSENT FORM
Alameda County Medical Center (ACMC) Department of Emergency Medicine
Study Title: Evaluation of an Emergency Department System Replacement Project Investigators
(names of the researchers): David K. English, MD

You should read and understand this form before continuing with the survey. We encourage you to ask the researcher questions about this research study. You may print a copy of this form to take home. Do not continue with the survey if you do not agree.

Why are we doing this study?
ACMC/AHS has decided to implement the Soarian EHR throughout Highland Hospital. Part of this project will replace the computer system used in the Emergency Department (Wellsoft™) with the ED module of the new EHR (Siemens Soarian™). The first attempt to make this change for the ED was terminated in December of 2012. We would like to understand the factors at ACMC/AHS, and between ACMC/AHS and the vendor, that prevented the project from going to completion.

Who can be in this study?
All healthcare providers, current and former ACMC/AHS staff and executives, consultants and vendor representatives engaged to work on the 2012 Soarian ED implementation attempt at ACMC/AHS.

How the study works:
The individuals listed above are asked to take an on-line survey, which follows this consent. The invitations will be made primarily by email, and in person at various conferences and meetings. The survey will be given once. Anyone who does not initially respond may receive several additional reminders. Willing members of the group may also participate in a brief interview. The interview will be recorded if the interviewee agrees.

Possible problems from participating in this study:
This study may be boring or time-consuming. Although unlikely, the questions may cause emotional distress or discomfort. Data entry on the computer may cause physical discomfort, such as soreness in the hands or wrists. After you have agreed to participate, you are still free to withdraw from the study (stop participating) at any time.

None of your personal health information will be collected in this study. Your name, email address, professional role, level of training, age, and gender may be collected. Your name and email address will be separated from your responses, and only used to track your completion of the study. The other items will be used only for aggregated statistics. Only the investigator will have access to your individual responses.

Possible benefits:

A successful study will provide insight into the successes and failures of the system replacement project. It will offer lessons for ACMC/AHS in how to conduct future projects, and may inform the broader health IT community of issues to be anticipated and mitigated.

Alternatives to participating in this study:

You may choose not to participate. Your work or training will not be affected. You may receive additional messages if you do not make your choice known.

Costs and Reimbursement:

It costs you nothing to participate in this study, except for your time. If you complete the survey, you will be entered in a drawing for one $25 gift card (odds of winning approximately 1 in 25). If you agree to be interviewed, you will receive a $10 gift card. If you do not complete the survey or interview, you will receive no payment for participating.

Confidentiality:

Your responses are confidential. Your responses will be kept separate from your identification. Your participation (but not your answers) will be tracked, to determine who has earned a gift card.

Voluntary Participation:

Participating in this study is voluntary. You may stop participating in the study at any time without penalty.

Questions, Problems, Follow-up:

If you have any other questions, concerns, or problems while participating in the study, or in the future, you are encouraged to speak with the study investigator. The study investigator is David K. English, MD. His email is xxxxxxx@xxxxxxxx.org and his phone number is 510-xxx-xxxx.

*1. Agreement to participate: I have read and understand the Consent Form. I have had sufficient opportunity to ask questions about the study and to discuss it with the investigator or anyone else of my choosing.

☑ I agree to participate (continue)   ☐ I do not want to participate (end survey)

Throughout this survey, "EDIS" (Emergency Department Information System) refers to the computer software used to manage patients in the Emergency Department of ACMC-Highland Campus. Wellsoft is the current EDIS, and Soarian is the planned EDIS. In December 2012 the project to install Soarian EDIS was postponed to a future date. Please tell us about your experiences and perceptions of the project to install Soarian EDIS in 2012, not any prior or subsequent implementation. Feel free to compare it to other system implementations you have experienced. Please comment freely - your comments may be the most valuable information of all.

Our focus is the Soarian EDIS implementation that was halted in December 2012.

2. For reporting purposes, we need some information about you. This will not be used to identify you in any report. This is for statistical analysis of the results. If none of the choices describe your role, please tell us in a comment.

	Department	**Role**
Position During 2012 Project	Emergency Department ▼	▼

Other (please specify)

3. What is your gender?

○ Female

○ Male

◉ Refused or Other

4. What is your age?

○ 18 to 24

○ 25 to 34

○ 35 to 44

○ 45 to 54

○ 55 to 64

○ 65 to 74

○ 75 or older

5. Think back to 2012 and your time on the project. How ready was ACMC/AHS as an organization for the new Soarian EDIS?

○ Extremely ready

○ Very ready

○ Moderately ready

○ Slightly ready

○ Not at all ready

Comment on readiness (please specify)

6. Again, think back to 2012 and your time on the project. From a technical standpoint, how ready was ACMC/AHS for the new Soarian EDIS?

○ Extremely ready

○ Very ready

○ Moderately ready

○ Slightly ready

○ Not at all ready

Comment on readiness (please specify)

7. How good was the communication between the ACMC/AHS team and the vendor team?

○ Extremely good

○ Very good

○ Moderately good

○ Slightly good

○ Not at all good

Comment (please specify)

8. How good was the communication within the ACMC/AHS project team?

○ Extremely good

○ Very good

○ Moderately good

○ Slightly good

○ Not at all good

Comment (please specify)

9. How good was the trust between the vendor team and the ACMC/AHS team?

○ Extremely good

○ Very good

○ Moderately good

○ Slightly good

○ Not at all good

Please Comment (please specify)

10. How important is a successful EDIS to you?

○ Extremely important

○ Very important

○ Moderately important

○ Slightly important

○ Not at all important

Other (please specify)

11. Overall, are you satisfied with the involvement of key personnel at ACMC/AHS, neither satisfied nor dissatisfied with it, or dissatisfied with it?

○ Extremely satisfied

○ Moderately satisfied

○ Neither satisfied nor dissatisfied

○ Moderately dissatisfied

○ Extremely dissatisfied

Comments (please specify)

12. Overall, are you satisfied with the involvement of key personnel at Siemens, neither satisfied nor dissatisfied with it, or dissatisfied with it?

○ Extremely satisfied

○ Moderately satisfied

○ Neither satisfied nor dissatisfied

○ Moderately dissatisfied

○ Extremely dissatisfied

Comments (please specify)

13. Do you like Siemens Healthcare, neither like nor dislike it, or dislike it?

○ Like a great deal

○ Like a moderate amount

○ Like a little

○ Neither like nor dislike

○ Dislike a little

○ Dislike a moderate amount

○ Dislike a great deal

Other (Confidential!)

14. Do you like ACMC/AHS, neither like nor dislike it, or dislike it?

○ Like a great deal

○ Like a moderate amount

○ Like a little

○ Neither like nor dislike

○ Dislike a little

○ Dislike a moderate amount

○ Dislike a great deal

Other (Confidential!) [text box]

15. How important is our EDIS to your job satisfaction?

○ Extremely important

○ Very important

○ Moderately important

○ Slightly important

○ Not at all important

Comments (please specify) [text box]

16. How user-friendly is the Soarian EDIS interface?

○ Extremely user-friendly

○ Very user-friendly

○ Moderately user-friendly

○ Slightly user-friendly

○ Not at all user-friendly

Other (please specify) [text box]

17. How successful do you believe the Soarian EDIS is (or will be) in performing its intended task?

○ Extremely successful

○ Very successful

○ Moderately successful

○ Slightly successful

○ Not at all successful

[text box]

Other (please specify)

18. How successful is our current EDIS (Wellsoft) in performing its intended task?

○ Extremely successful

○ Very successful

○ Moderately successful

○ Slightly successful

○ Not at all successful

[text box]

Other (please specify)

19. How useful is the included help and documentation for the Soarian EDIS?

○ Extremely useful

○ Very useful

○ Moderately useful

○ Slightly useful

○ Not at all useful

[text box]

Other (please specify)

20. Based on your experience in 2012, how often does the Soarian EDIS freeze or crash?

○ Extremely often

○ Very often

○ Moderately often

○ Slightly often

○ Not at all often

[text box]

Other (please specify)

21. Overall, are you satisfied with the resources that ACMC/AHS devoted to the project, neither satisfied nor dissatisfied with them, or dissatisfied with them?

○ Extremely satisfied

○ Moderately satisfied

○ Neither satisfied nor dissatisfied

○ Moderately dissatisfied

○ Extremely dissatisfied

Comments (please specify)

22. Overall, are you satisfied with the resources that Siemens devoted to the project, neither satisfied nor dissatisfied with them, or dissatisfied with them?

○ Extremely satisfied

○ Moderately satisfied

○ Neither satisfied nor dissatisfied

○ Moderately dissatisfied

○ Extremely dissatisfied

Comments (please specify)

23. How good was the project team's understanding of the clinical workflow at ACMC/AHS?

○ Extremely good

○ Very good

○ Moderately good

○ Slightly good

○ Not at all good

Comment (please specify)

24. How good was the Siemens team understanding of the clinical workflow at ACMC/AHS?

○ Extremely good

○ Very good

○ Moderately good

○ Slightly good

○ Not at all good

Comment (please specify)

25. How well does Soarian EDIS support the clinical workflow at ACMC/AHS?

○ Extremely good

○ Very good

○ Moderately good

○ Slightly good

○ Not at all good

Comment (please specify)

26. How likely are you to recommend the Soarian EDIS to others?

○ Extremely likely

○ Very likely

○ Moderately likely

○ Slightly likely

○ Not at all likely

Other (please specify)

27. How likely are you to recommend the Wellsoft EDIS to others?

○ Extremely likely

○ Very likely

○ Moderately likely

○ Slightly likely

○ Not at all likely

Other (please specify)

28. How good was the workflow within the ACMC/AHS project team?

○ Extremely good

○ Very good

○ Moderately good

○ Slightly good

○ Not at all good

Comment (please specify)

29. How good was the collaboration within the ACMC/AHS project team?

⦿ Extremely good

○ Very good

○ Moderately good

○ Slightly good

○ Not at all good

Comment (please specify)

30. How well do the technical support representatives at Siemens answer your questions?

○ Extremely well

○ Very well

○ Moderately well

○ Slightly well

○ Not at all well

Other (please specify)

31. How good was the collaboration between Siemens staff and the ACMC/AHS project team?

○ Extremely good

○ Very good

○ Moderately good

○ Slightly good

○ Not at all good

Comment (please specify)

32. How good was the trust between the ACMC/AHS project team and the Siemens team?

○ Extremely good

○ Very good

○ Moderately good

○ Slightly good

○ Not at all good

Comment (please specify)

33. How good was the trust within the ACMC/AHS project team?

○ Extremely good

○ Very good

○ Moderately good

○ Slightly good

○ Not at all good

Comment (please specify)

34. How easy is it to find the information you are looking for within the Soarian EDIS?

○ Extremely easy

○ Very easy

○ Moderately easy

○ Slightly easy

○ Not at all easy

Other (please specify)

35. How easy is it to find the information you are looking for about the Soarian EDIS?

◉ Extremely easy

○ Very easy

○ Moderately easy

○ Slightly easy

○ Not at all easy

Other (please specify)

36. How well did our internal ACMC/AHS project managers handle the Soarian EDIS project?

○ Extremely well

○ Very well

○ Moderately well

○ Slightly well

○ Not at all well

Other (please specify) [   ]

37. How well did Siemens project or account managers handle the Soarian EDIS project at ACMC/AHS?

○ Extremely well

○ Very well

○ Moderately well

○ Slightly well

○ Not at all well

Other (please specify) [   ]

38. Was your experience with technical support at Siemens better than you expected it to be, worse than you expected it to be, or about what you expected it to be?

○ Much better

○ Somewhat better

○ About what was expected

○ Somewhat worse

○ Much worse

Other (please specify) [   ]

39. How responsive is Siemens leadership to the ACMC Soarian EDIS project?

○ Extremely responsive

○ Very responsive

○ Moderately responsive

○ Slightly responsive

○ Not at all responsive

Other (please specify)

40. How responsive is ACMC/AHS leadership to the Soarian EDIS project?

○ Extremely responsive

○ Very responsive

○ Moderately responsive

○ Slightly responsive

○ Not at all responsive

Other (please specify)

41. Overall, are you satisfied with the decision to postpone the Soarian EDIS go-live, neither satisfied nor dissatisfied with it, or dissatisfied with it?

○ Extremely satisfied

○ Moderately satisfied

○ Neither satisfied nor dissatisfied

○ Moderately dissatisfied

○ Extremely dissatisfied

Comment (please specify)

42. How should we improve the Soarian EDIS?

43. Previous research has identified several themes that are important to successful system implementations. Please rank the items below to reflect how important these items are to you (1 is MOST important).

[▼] Collaboration and trust within the team

[▼] Collaboration and trust with the vendor

[▼] Communication within the organization

[▼] Communication with vendor

[▼] Involvement level of key personnel

[▼] Leadership

[▼] Resources devoted to the project

[▼] Workflow complexity

[▼] Value to end-users

44. Do you have any other thoughts or comments about the Soarian ED project at ACMC/AHS?

[text box]

45. Are you willing to participate in a brief interview (20 minutes average) for this project? The interviews must be done the week of Mxxx xx-xx and may be done by phone. Those who are interviewed will receive a $10 gift card as a token of thanks.

If you are interested in the interview, please enter your name and preferred contact information in the box below. Your responses to the survey and the interview will be kept private.

Name [ ]

Email Address [ ]

Contact Phone [ ]

REFERENCES

[1] Wellsoft EDIS. Somerset, NJ: Wellsoft Available at: www.wellsoft.com. Accessed May 16, 2013.

[2] Soarian Clinicals. Malvern, PA: Siemens Medical Solutions USA, Inc. Available at: http://usa.healthcare.siemens.com/infrastructure-it/healthcare-it/acute-care/soarian-clinicals-usa. Accessed May 16, 2013.

[3] EHR Incentive Programs - Centers for Medicare & Medicaid Services. Available at: https://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/index.html. Accessed May 14, 2013.

[4] Hochstettler TJ, McFarland BP, Martin A, Watters Jr. JA. Simultaneous Process Reengineering and System Replacement at Rice University. Available at: http://net.educause.edu/ir/library/html/cem/cem99/cem9933.html. Accessed July 15, 2012.

[5] Y2K--The Year 2000 Bug Crisis. Available at: http://courses.cs.vt.edu/cs3604/lib/Y2K/Y2K.Overview.html. Accessed May 14, 2013.

[6] Komperud M. Top 10 Risks in IT System Replacement Projects (and How to Mitigate Them), Part 1. 2012. Available at: http://info.sagitec.com/blog/bid/113051/Top-10-Risks-in-IT-System-Replacement-Projects-and-How-to-Mitigate-Them-Part-1. Accessed July 15, 2012.

[7] Clark T. Health Care technology Replacement Planning. 2008. Available at: http://ebsloane.com/PAHO-ECC/Clark_Replacement_Day%202_430.pdf. Accessed September 3, 2012.

[8] Sikkel K, Spil TAM, van de Weg RLW. Replacing a hospital information system: an example of a real-world case study. In: IEEE; 1999:6–15. doi:10.1109/CSEE.1999.755174.

[9] Lapointe L, Rivard S. Getting physicians to accept new information technology: insights from case studies. CMAJ. 2006;174(11):1573–1578. doi:10.1503/cmaj.050281.

[10] Paré G, Sicotte C, Jaana M, Girouard D. Prioritizing the risk factors influencing the success of clinical information system projects. A Delphi study in Canada. Methods Inf Med. 2008;47(3):251–259.

[11] Takian A, Sheikh A, Barber N. We are bitter, but we are better off: case study of the implementation of an electronic health record system into a mental health hospital in England. BMC Health Serv Res. 2012;12:484. doi:10.1186/1472-6963-12-484.

[12] Aarts J, Doorewaard H, Berg M. Understanding implementation: the case of a computerized physician order entry system in a large Dutch university medical center. J Am Med Inform Assoc. 2004;11(3):207–216. doi:10.1197/jamia.M1372.

[13] Peute LW, Aarts J, Bakker PJM, Jaspers MWM. Anatomy of a failure: a sociotechnical evaluation of a laboratory physician order entry system implementation. Int J Med Inform. 2010;79(4):e58–70. doi:10.1016/j.ijmedinf.2009.06.008.

[14] Gettinger A, Csatari A. Transitioning from a Legacy EHR to a Commercial, Vendor-supplied, EHR. Applied Clinical Informatics. 2012;3(4):367–376. doi:10.4338/ACI-2012-04-R-0014.

[15] VanWagenen S. EDIS 2011 - Delivering on Great Expectations.; 2011. Available at: www.klasresearch.com. Accessed September 3, 2012.

[16] NextGen Ambulatory EHR. Horsham, PA: NextGen Healthcare Available at: http://www.nextgen.com. Accessed May 16, 2013.

[17] Elliott S. Fisher, Douglas O. Staiger, Julie P.W. Bynum, and Daniel J. Gottlieb, "Creating Accountable Care Organizations: The Extended Hospital Medical Staff," Health Affairs 26, no. 1 (2007: w44–w57 (published online 5 December 2006; 10.1377/hlthaff.26.1.w44)

[18] Read the Law | HealthCare.gov. Available at: http://www.healthcare.gov/law/full/index.html. Accessed May 15, 2013.

[19] SELECTED LIST OF SIEMENS ME DICAL SOLUTIONS USA, INC. TRADEMARKS, REGISTERED TRADEMARKS AND SERVICE MARKS. Malvern, PA: Siemens Medical Solutions USA, Inc. Available at: http://usa.healthcare.siemens.com/siemens_hwem-hwem_ssxa_websites-context-root/wcm/idc/groups/public/@us/@healthit/documents/download/mdaw/njc2/~edisp/trademarks_list_siemens_med_usa-00448451.pdf. Accessed May 16, 2013.

[20] Novius Laboratory. Malvern, PA: Siemens Medical Solutions USA, Inc. Available at: http://usa.healthcare.siemens.com/infrastructure-it/healthcare-it/acute-care/specialty-solutions/specialty-solutions-novius-lab. Accessed May 16, 2013.

[21] syngo.via. Malvern, PA: Siemens Medical Solutions USA, Inc. Available at: http://usa.healthcare.siemens.com/medical-imaging-it/clinical-imaging-applications/syngovia. Accessed May 16, 2013.

[22] McKesson Horizon. San Francisco, CA: McKesson Available at: http://www.mckesson.com/en_us/McKesson.com/For%2BHealthcare%2BProviders/Hospitals/About%2BHorizon/About%2BHorizon.html. Accessed May 16, 2013.

[23] EMR Adoption Model , http://www.himssanalytics.org/hc_providers/emr_adoption.asp accessed 29 August 2010

[24] EHR Incentive Programs - Centers for Medicare & Medicaid Services. Available at: https://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/index.html. Accessed May 14, 2013.

[25] English DK. Evaluation of an Externally-Imposed Clinical System Replacement Project. Prepared for BMI 560, OHSU; September 2012.

[26] Cronin, S. (2013, May 9). Overtime Costs for Soarian. Email.

[27] Harris AD. The Use and Interpretation of Quasi-Experimental Studies in Medical Informatics. Journal of the American Medical Informatics Association 2005 Oct;13(1):16–23.

[28] Peute LW, Aarts J, Bakker PJM, Jaspers MWM. 2010. op. cit.

[29] Koppel R, Metlay JP, Cohen A, Abaluck B, Localio AR, Kimmel SE, Strom BL. Role of computerized physician order entry systems in facilitating medication errors. JAMA 2005 Mar;293(10):1197–1203.

[30] Questionnaire For User Interaction Satisfaction [Internet]. [date unknown];[cited 2012 Aug 5] Available from: http://lap.umd.edu/quis/

[31] SurveyMonkey. Palo Alto. CA: SurveyMonkey Available at: http://www.surveymonkey.com/. Accessed May 16, 2013.

[32] Hedman J and Borell A (2005) "Broadening Information Systems Evaluation Through Narratives" The Electronic Journal of Information Systems Evaluation, Vol. 8, Iss. 2, pp 115-122, available online at http://www.ejise.com

[33] Harrison MI, Koppel R, Bar-Lev S. Unintended consequences of information technologies in health care--an interactive sociotechnical analysis. J Am Med Inform Assoc 2007 Oct;14(5):542–549.

[34] Lapointe L, Rivard S. 2006. op. cit.

[35] Paré G, Sicotte C, Jaana M, Girouard D. 2008. op. cit.

[36] Hochstettler, et. al. Simultaneous Process Reengineering and System Replacement at Rice University. op. cit.