iJLR: An Ergonomic Intervention

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March 17, 2017

Abstract

JLR Medical Group has a fragmented and ineffective data dissemination model for the increasingly mobile anesthesia practitioners. JLR Medical group provides anesthesia coverage for over 40 clinical sites in the central Florida area. The demand of mobile dependence for data recruitment highlights the need for a current portable model. A mobile application platform was proposed to synchronize the complexity of scheduling, data dissemination, and anesthesia team communication throughout clinical sites. The proposal was based upon the first two phases of the software development lifecycle for proposed clinical information systems – namely analyze and design. The analysis stage consisted of identifying the specifics of the problem, researching options for probable solutions, instituting a vision of the solution, and acquiring information concerning the technological milieu of key stakeholders. The design stage included a storyboard development of a mobile application wireframe consistent with the technological specifications of JLR and Florida Hospital. Furthermore, platforms requirements were explored for data recruitment from several information systems. The proposal was presented in PowerPoint format to key stakeholders of JLR medical group, consisting of two MDs in leadership and one IT personnel. The development of the PowerPoint presentation entailed background research for educating the audience. The proposal was evaluated by a response via a feedback form comprised of three sections with nine total questions. The resultant Likert-scale and opened ended questions of the three respondents indicated a strong agreement and likelihood of pursing the proposed solution. The initial goals of the project were achieved by the completion of the proposal in a professional manner, which included obtaining written responses from the committee regarding the strengths and weaknesses of the presentation.

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Problem

Joseph L. Riley (JLR) Medical Group consists of 76 anesthesiologists and 169 Certified Registered Nurse Anesthetists (CRNA) practicing at over 40 clinical sites throughout central Florida (www.jlrmedical.com). In addition, the number of clinical sites covered continues to grow, leading to an eventual influx of new practitioners. Moreover, Student Registered Nurse Anesthetists (SRNAs) from Adventist University of Health Sciences (ADU) Nurse Anesthesia Program (NAP) may add an additional 25 practitioners for a single cohort and up to 50 practitioners to this body during the months when two cohorts are active in clinical. This enormous group of clinicians combined with numerous clinical sites demands tremendous coordination and data throughput for the JLR Medical Group administration to handle.

The nature of anesthesia requires a clinical practitioner to be mobile and resourceful considering the vastly complex variations of teams, clinical sites, and patient types. In addition, even though these assignments are distributed daily, reassignment of practitioners continues throughout the day, given the staffing demand of different clinical sites. Hence, communication and data dissemination are crucial for JLR to function efficiently and effectively. However, communication and data are channeled through fragmented avenues such as: emails, the JLR webpage, updated web links, PDF files, text messages, message boards, Google documents, and many other avenues of communication. Moreover, the roving practitioner relies heavily upon data retrieval through his or her mobile device. Accessing the different data points of JLR from a mobile device may be burdensome. The current JLR website is designed and formatted for webpage access by a desktop computer. Furthermore, JLR outsources data management requiring practitioners to recruit data from additional websites costing time and money.

This project proposed a mobile application to synchronize the complexity of scheduling, data dissemination, and anesthesia team communication throughout clinical sites. For example, a mobile application would enable a dashboard of information to be pulled from different channels of JLR communications to enable the practitioner to quickly reference current team members, contact information, clinical site details, operating room (OR) schedules, or even photo identification of differing team members. Although a brief literature review acknowledged the benefits of mobile devices to practitioners and patients, JLR lacked a specific plan of implementation (Mickan, Tilson, Atherton, Roberts, & Heneghan, 2013). The research, design, and presentation of a mobile platform require a specific, tailored business proposal to the informational technology (IT) department and leadership of JLR. In addition, specific research to the plausibility, benefits, cost analysis, and data retrieval channels would need to be outlined. For example, retrieving OR schedules for specific rooms would require coordination with the Florida Hospital IT department to understand the specifications of coding protocols. Likewise, contact information and timelines for completion would need to be established. However, no such plan had been explored. A disparity exists between the growing practice of JLR, the shifting trend of mobile access to data, and the present dissemination of data by JLR through email and a webpage interface meant for desktop computers.

Review of Literature

At the turn of the century, according to the Institute of Medicine (IOM), the Committee on the Quality of Health Care in America was formed to develop a strategy to improve the quality of health care. The Committee proposed six aims for improving health care in America, which included delivering care that is safe, effective, patient-centered, timely, efficient, and equitable (Institute of Medicine, 2001). The IOM adopted 13 recommendations to track and monitor the progress of meeting the above-referenced six aims. Moreover, the ninth recommendation called for a renewed national commitment to building an informational infrastructure that supports a timely, efficient, and safe health care system for the public (Institute of Medicine, 2001). Hence, the beginning of the 21st Century ushered in the electronic medical record era. Major hospital systems began implementing electronic medical records. However, recommendation seven specifically endorsed “the research community to identify, adapt, and implement state-of-the-art approaches” to improve the “use of information technologies” and “coordination of care across patient conditions, services, and settings over time” (Institute of Medicine, 2001, p. 12). Therefore, the transition of information from paper to computer must be continued in the spirit of effectiveness and efficiency.

Free et al. (2013) describes the dramatic current trends towards mobile-device dependency, while highlighting a significant (approximately 64%) reduction in electronic health record login times. Besides increased productivity, providers found “improved communications with their patients, the process of care, and technology efficiencies” as positive gains of mobile devices (Free et al., 2013, p. 8). Moreover, the use of mobile devices is becoming increasingly native to the anesthesia provider. Noteworthy, 87% of anesthesia providers are using a smartphone or tablet device in their workplace, in comparison to 99% who use a computer. Thirteen different surveys have shown that approximately 80% of physicians use an iPhone, while most of the remainder opt for Android smartphones. In addition, an estimated 66% of doctors own a tablet computer, while 54% use the device in their practices (Ventola, 2014). Nonetheless, several assumptions to the benefits of mobile technologies must not be understated. Chaudet, Anceaux, Beuscart, Pelayo, and Pellegrin (2014) describe the hazards of designing a distributed cognitive situation without accounting for end-user burdening leading to disengagement of the practitioner:

> When IT systems are designed from a prescribed/theoretical task and not from real activity, it may result in a loss of adaptability or a lack of resilience as far as they do not allow humans to implement adaptive capacities. An increase of mental load may also occur: firstly when interfaces show too much information at the same time, overloading the human work memory; secondly when the operator needs to understand the system functioning in addition to his “normal” activity (pp. 468-469).

In short, cognitive distribution systems must be designed to reduce the mental capacity and work of the practitioner (Prgomet, Georgiou, & Westbrook, 2009). Chaudet et al. (2014) recommend evaluation of fundamental qualities, specifically: utility, usability, and acceptability. Hence the ergonomics of a system (mobile application) with the user (practitioner) may be evaluated based on a work situation analysis identifying the users, tasks, task activities, and the environment of this relation (Colton & Hunt, 2016).

In light of an end-user work situation analysis, a brief overview of the current JLR system compared to a suggested mobile application platform designed for JLR practitioners profoundly highlights the disparity. Briefly, JLR has allowed the burden of data retrieval to rest upon the end-user instead of the computer system. A redesign of this system geared toward a mobile platform would greatly enhance the data of multiple sources in a form applicable to the practitioner. In order to achieve this change, the practitioner must first understand the technological infrastructure.

Open systems theory is a universal grand theory to describe the input, throughput, and output cycle of living systems with ongoing exchange of matter, energy, and data (Johnson &

Webber, 2005). The shift of data access to the mobile device platform changes the architecture of the health care infrastructure. Therefore, a brief understanding of the current trends of IT systems serves to leverage the advantages of the mobile platform. Simply stated, the open system theory cycle may be practically understood as the receiving and sending of information over a network. Murphy, Klann, and Meeks-Johnson (2016) provide an excellent sample of an obstetrics system dataflow diagram (Appendix A). Information is dynamically requested, processed or retrieved, and sent from multiple users interacting with multiple databases. Note in Appendix B in the enterprise architecture sample diagram, providers are separated by multiple levels of technological architecture. In addition, transferring data must have a standard of practice.

The International Standards Organization (ISO) has established a 7-layer Open Systems Interconnection (OSI) network model in order to categorize network devices with subnets (Appendix C). In other words, how are subsystems delineated in a multifaceted system? Moreover, this classification allows for standardization of languages for applications to "talk" to one another. Noteworthy, in Appendix C, the "HL7" refers to a "Health Level-7." HL7 is the international standard for transfer of administrative data between health software applications on various servers (Chinniah & Muttan, 2012). The universal language specifies guidelines, protocols, and methodologies allowing information to be shared and processed in a uniform manner. A full understanding of the health care Information Technology (IT) architecture allows for the integration of a newer addendum for efficiency and effectiveness.

Clinical Information Systems (CIS) follow specific phases of a software development lifecycle (SDLC). The phases are: analyze, design, implement, maintain, evaluate, and then cycled to analyze again (Sengstack, 2016). First the need for the new CIS is identified with support for change at the highest level of decision makers. The goal of the CIS should completely align with the organization's strategic plan (Smith & Tyler, 2011). Moreover, this phase should address the problem and a proposed CIS solution. For example, data dissemination and clinical coordination in JLR is fragmented across several platforms. Would a mobile application result in centralized, effective, and efficient dissemination of data? In addition, several questions surrounding the need may be addressed. Will it save money? Will patient care benefit? What is the estimated cost? How will risk be mitigated? Justification will depend on monetary cost and human capital. In like manner, an inventory should be taken of the IT departments of all participating parties including: organization, personnel, hardware and software, and protocols for CIS rollouts. The SDLC may deviate if the organization chooses to purchase an outside vender CIS or develop the CIS from within the IT department. The following cycle will delineate internal development. However, a Request for Information (RFI) and a Request for Proposal (RFP) from an outside vendor may help as a benchmark for the internal proposal analysis (Sengstack, 2016). An internal team should be employed using the same standards of information as a proposed, external development of the CSI.

In terms of enterprise mobile application development, outlining the framework of the mobile application continues the analyzing stage. A storyboard or wireframe is "a way to visually lay out your app's interface and the sequencing of screens" (Feiler, 2014, p. 88). This wireframe serves as the general workflow of the application. The wireframe may also be used as the foundation for gathering required resources for the project. This inventory should attempt to complement the existing architecture of the key stakeholder parties involved. The inventory should attempt to include: technical requirements, functional requirements, potential risks with mitigation, ongoing resources needed, support provided, and total cost of ownership. In addition, development teams may be assigned in order to further analyze the development and deployment of the mobile application. A preliminary budget may also help to establish goals and limitations of the project.

The design phase includes specifying concrete mobile application storyboards. In addition, this design allows for timeframe planning. “Human resources are often the most costly and difficult to manage on a project” (Bove, Kennedy, & Houston, 2016, p. 399). Therefore, workforce teams will need to be delegated to front-end, backend, and user-interface design developing teams. These teams should be overseen by the technical lead. In addition, a business analyst and financial analyst provide additional supporting roles. The project manager should oversee the coordination of all teams in conjunction with a stated timeline. Estimated budgets will require planning of labor force billable hours, software and hardware costs, and maintenance costs.

Software development methodology will highly depend on these first two phases. Implementation may occur in a short cycle (30 days or less) staged release (Murphy, Klann, & Meeks-Johnson, 2016). Therefore, implementation, maintenance, and evaluation are a continual, spiral process for constant quality improvement. This methodology follows a hybrid of waterfall versus iterative models for general application development concepts.

Project Description

A mobile application platform was proposed to synchronize the complexity of scheduling, data dissemination, and anesthesia team communication throughout clinical sites. The proposal was presented in PowerPoint format (Appendix J) to key stakeholders of JLR medical group, consisting of two MDs in leadership and one IT personnel. In order to accomplish this proposal, the initial groundwork for the first two phases, analyze and design, specific to the SDLC of the proposed CIS were followed. The first stage of the analysis required generalized concerns for need, purpose, and practicality. Appendix D supplied questions of the analyzing stage that were answered at the forefront of the initial research for the proposal. These questions were designed to be answered by the researchers as a primer for information gathering and mobile application design. For example, the lack of a mobile application platform in light of the heavy clinical use of mobile devices highlighted the need for the system. In addition, the timing of this project research paralleled an initiative by JLR to convert from paper to online charting for quality control. Hence, the application development was well-suited for the strategic plan of the company. The initiative allowed observation of conversion impact during student clinical rotations while gathering initial feedback from the JLR IT department persons.

The answers to the analyzing stage questions of Appendix D drove the initial development of a wireframe to serve as a foundation for the proposed CIS. In addition, these questions served as a framework for the data collected in later stages of the development process. For example, the researchers focused on the design and development of the schedule portion of the wireframe. Although the platform would be multifunctional, the scheduling portion was suggested by JLR IT as the mainstay of the platform. Hence, the analyzing stage questions of Appendix D served as the basic foundation for decision-making about the design of the mobile application. Balsamiq Mockups Version 3.3.14 was used to create a wireframe or storyboard for the proposal. Thereafter, specifications for the planning and design of the CIS were required concrete details.

A brief evaluation and inventory of JLR technology resources were required to determine the personnel and resources available, the full description of the channels of communication used, and the available cross-platform communications. A comprehensive inventory questionnaire of the IT infrastructure provided insight into the anticipated needs and development of the CIS (Appendix E). The data for the questionnaire was obtained by interviewing a key member of the JLR Medical Group's IT department. The interview solely focused on information recruitment of the IT infrastructure of each corporation. The questions were answered through qualitative data collection via interviews with the JLR management and IT departments as a primer for further research. The primary researchers conducted the interviews – namely, Jon Christophersen and Shawn Sturgis. The timeframe of the interviews was dependent upon the convenience of the interviewee within the parameter of one hour. The interviews took place at the JLR corporate office or at the South Campus of Florida Hospital on the afternoon of September 28th, 2016. The interviews were structured based upon the specific data required from each interviewee. In addition, before the interviews began, the interviewees were asked to give consent by reading and signing the consent form (Appendix F).

The information gathered revealed JLR stores data on JLR servers. However, JLR also hosts four websites on JLR webservers. Website development is outsourced to Rise Creative Group. In addition, a free and open source content-management framework, Drupal is used for web application management. Drupal is founded upon the server-side scripting language of Personal Home Page Hypertext Preprocessor (PHP). Initially user interfaces were developed with Microsoft Active Directory accompanied with Microsoft Exchange for email access. Database storage is accessed through Structured Query Language (SQL) while data-interchange format for data recruitment entails JavaScript Object Notation (JSON). JLR utilizes data storage for a myriad of reasons. However, the mainstay of data usage encompasses billing utilities and quality improvement. The online quality documentation initiative changed directions to use the mobile-friendly Angular 2 platform for webpage design. Angular 2 is an open-sourced, JavaScript-based, front-end web application framework maintained by Google.

Once understood, the data collected served as a roadmap of components, which needed to be streamlined into a useful design and interface for "in-field" practitioners. A mock prototype of a mobile application was designed with task lists of jobs and resources. See Appendix G for a mock example of the JLR mobile application wireframe. The design phase then shifted to an estimated time frame for the project. This time frame allowed for a preliminary cost-benefit analysis. The results of the first two phases of the SDLC rendered a compilation of the information into a proposal. The CIS proposal followed the general outline of a RFP in order for a fair analysis. The proposal presentation outline of Appendix H denotes the suggested RFP elements in a checklist format. In addition, the audience of the proposal drew key stakeholders of JLR Medical Group, including one board member, one additional MD, and an IT representative. Other employees of JLR were welcomed upon request, but only the aforementioned personnel attended. The meeting place and time of the proposal and PowerPoint presentation (Appendix J) were determined by the workflow of the first two phases and the availability of the key stakeholders. The tentative planned proposal date was initiated by email for December 14, 2016. However, due to scheduling conflicts, the proposal was postponed to Wednesday, January 4 at the JLR Office. The presentation lasted one hour with fifteen minutes included for proposal discussion. Lastly, all key stakeholders in attendance signed informed consent before the presentation began and agreed to provide feedback to the proposal. The feedback forms were completed by the participants and returned to the presenters for analysis. Contact information was provided to the participants for future inquires into the solution.

Evaluation Plan

The measurable outcomes of this project were: the completion of the proposal in a professional manner to the key stakeholders and the JLR project committee, a written response from the committee to the strengths and weaknesses of the presentation, and the acceptance or rejection of the proposal. Written responses were provided through the mixed methodology feedback form (Appendix I), and data obtained was utilized to provide descriptive statistics. The proposal presentation included an informed consent form, which was read and signed by the participants prior to the beginning of the presentation (Appendix F). The evaluation included additional research and analysis needed to complete the project in order to evaluate the effectiveness of the proposal. In addition, a survey was provided to the attendees was to aide an in-depth analysis of the proposal and plausibility of the plan. The written response may guide future opportunities for development of the proposal while highlighting areas of concern not addressed.

All feedback received was reported to the NAP chair, detailing questions, possible improvements, acceptance or rejection and all pertinent information. The purpose of this project was to collect the necessary informational, technological architecture of JLR and Florida Hospital in order to present a satisfactory proposal to a group of key stakeholders of JLR leadership for the undertaking of a mobile application for the JLR anesthesia practitioners. In this endeavor, it was important to understand that the intention of this project was to gather support with the hopes of future expansion.

The feedback form, utilizing mixed methods including Likert scale and open ended written responses, was distributed to the JLR project committee in order to elicit feedback about the proposal feasibility and garner information regarding the acceptance or rejection of the proposal (Appendix I). The JLR project committee provided additional oral feedback during a discussion period of the session after the proposal presentation. Moreover, the JLR project committee was invited to write a response to the presentation in the feedback form if they choose to do so in the event they have questions or require further clarification. Thereafter, the proposal feedback form data was evaluated. The quantity of data did not allow for statistical analysis. Therefore, the Likert scale data was compared by descriptive analysis. Likewise, written responses were examined qualitatively and presented in a descriptive format.

The committee was not able to immediately provide acceptance or rejection of the project. Although the committee responded positively to the proposal, the proposal researchers provided ancillary information requested in the confines of what was considered reasonably acceptable by the researchers. If the pursuit was beyond the researchers' capability, suggestions were provided as to possible solutions to the questions elicited.

Results and Conclusions

All three participants responded to the proposal feedback form by completing the form (Appendix I). The JLR Mobile App Proposal Feedback Form comprised of three sections with nine total questions. The first two questions explored the current long-term solutions to JLR's mobile technology issues. Interestingly, one respondent indicated "NO" current long-term plan, while the two other respondents responded by circling "YES." The second question was contingent upon the first question. If the respondent answered "NO" to the first question, the second question ascertained the interest of adding the solution to a long-term plan of JLR. The sole "NO" respondent of the first question did indicate interest in adding this solution by circling "YES" in question two.

The second section of the form used a Likert Scale of one through five for questions three through six. In the Likert Scale, number one was anchored with the descriptor “Strongly Disagree,” while the number five was anchored with the descriptor “Strongly Agree.” Question three considered the congruity of the proposed solution with the gaps of the current solution. All respondents circled five. Question four considered the application of the solution with the IT vision of the future of JLR. Two respondents circled five, while one respondent circled four, resulting with an average score of 4.6. Question five considered the persuasion of the proposal with the likelihood of pursing the proposed solution. Two respondents circled four, while one respondent circled five, resulting with an average score of 4.3. Question six considered the immediate benefit to the employee and organization, to which all respondents circled five. The average response to the Likert scale questions three through six was 4.7.

The third section of the form used open-ended questions to acquire a written response. One respondent did not complete this portion of the form. Question seven asked for the highest priority feature of the solution. In response, both respondents deemed the HL7 scheduling feed from Florida Hospital as the highest priority. Question eight asked for the lowest priority feature of the solution. The respondents differed, naming the surgeon preferences and the news and education sections as the lowest priority. Lastly, question nine asked what additional features the solution could include. One respondent elicited secure text messaging, while the other respondent noted the entirety of the solution as planned with no additions needed.

The overall response of the JLR Mobile App Proposal Feedback Form demonstrated a strong positive response to the presentation and solution proposal. In addition, the discussion portion of the presentation reflected much interest and desire for follow-up in the proposal. One participant asked for a full solution within six months if possible. Given the obvious need for improvement on the data dissemination of JLR and positive response, the researchers believe the anticipated outcomes of the proposal were achieved. The proposal was completed in a professional manner to the key stakeholders and the JLR project committee. Written responses were obtained from the committee in regard to the strengths and weaknesses of the presentation. Finally, the acceptance of the proposal or at least the concept of the proposal was accepted, given the positive feedback in discussion and the aforementioned feedback form.

Based upon the depth and breadth of this project, several limiting factors may be considered. Given the ever-changing landscape of technology and the rapid evolution of medicine, the proposal was conceptual in nature. This approach maximized efforts for persuasion without wasted effort on outdated technological examples. However, the proposed solution required a brief discourse on several technological fronts in order to inform the attendees of the how the researchers arrived at certain conclusions. In short, many components of the mobile application may have required more than an abbreviated explanation in the presentation. In addition, the complex dynamic of JLR merging with USAP while serving Florida Hospital limited the different solutions in order to be compliant with all three technological landscapes. Moreover, Florida Hospital was very delinquent in responding to requests from JLR for HL7 data services, hindering development of working examples of a mobile solution by the researchers. Lastly, the rapid changes made to the Angular platform by Google rendered several working examples of the mobile application coding as useless. Although this example was not required in order to meet the expectations of the project, the working example may have further influenced JLR to immediately pursue the solution. The application of learning this lesson resulted in the researchers recommending that JLR switch platforms to the competing JavaScript platform React by Facebook.

The potential implications of applying the proposed solution to the dissemination of data opens compounding opportunities for improved communication, education, coordination, and efficacy of nursing practice. These improvements may result in increased provider employment satisfaction, increased patient safety, and monetary rewards for improved throughput of provider service. In addition, preparedness of the anesthesia provider tailored to the specific case and surgeon would allow for increased anticipation of needs and safety issues. Moreover, time to response would be reduced in emergency situations, namely – data recruitment and communication requesting help. These safety measures alone would allow for the marginalization of risk. Lastly, the potential for artificial intelligence implementation would allow for a dramatic reduction in the cost of overhead, in terms of staff and labor cost.

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Appendix A

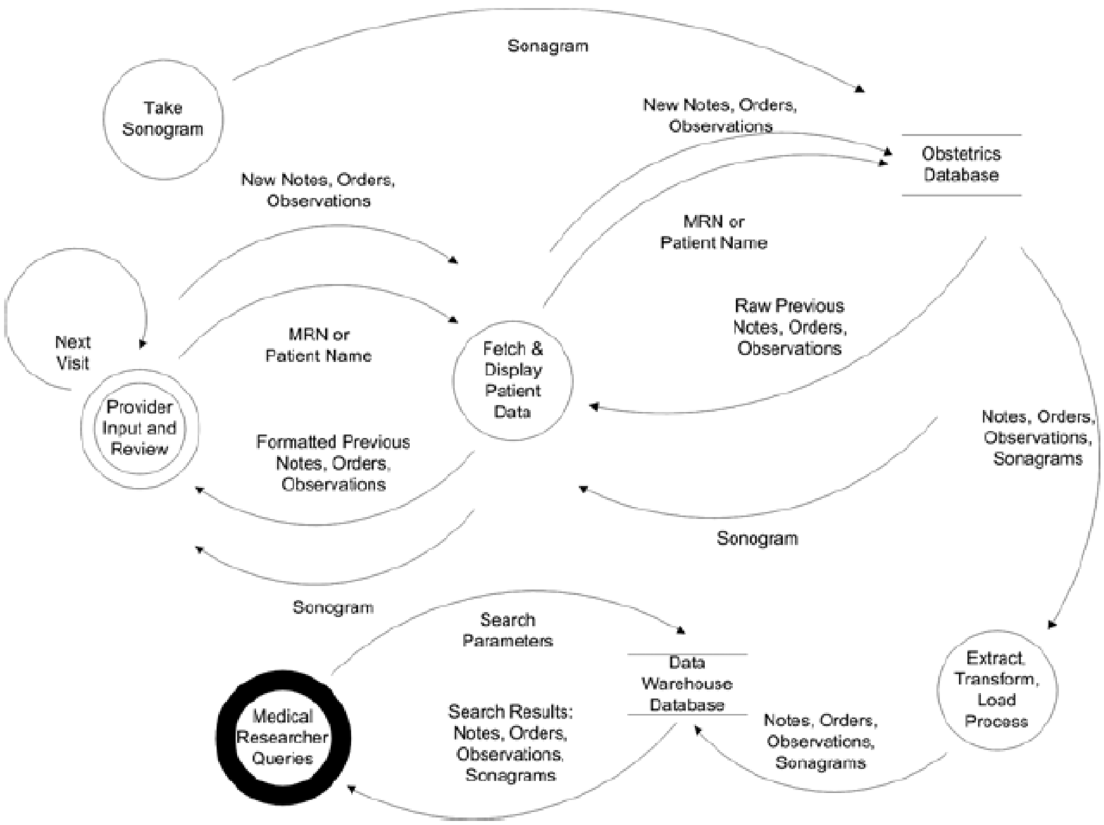


Fig. 9.4 Dataflow diagram of sample obstetrics system

Image taken from:

Murphy, S. N., Klann, J. G., & Meeks-Johnson, J. (2016). Ch. 9: Information Technology Systems. In Finnell, J. T. *Clinical informatics study guide: Text and review* (1st ed.). Cham: Springer International Publishing. doi:10.1007/978-3-319-22753-5

Appendix B

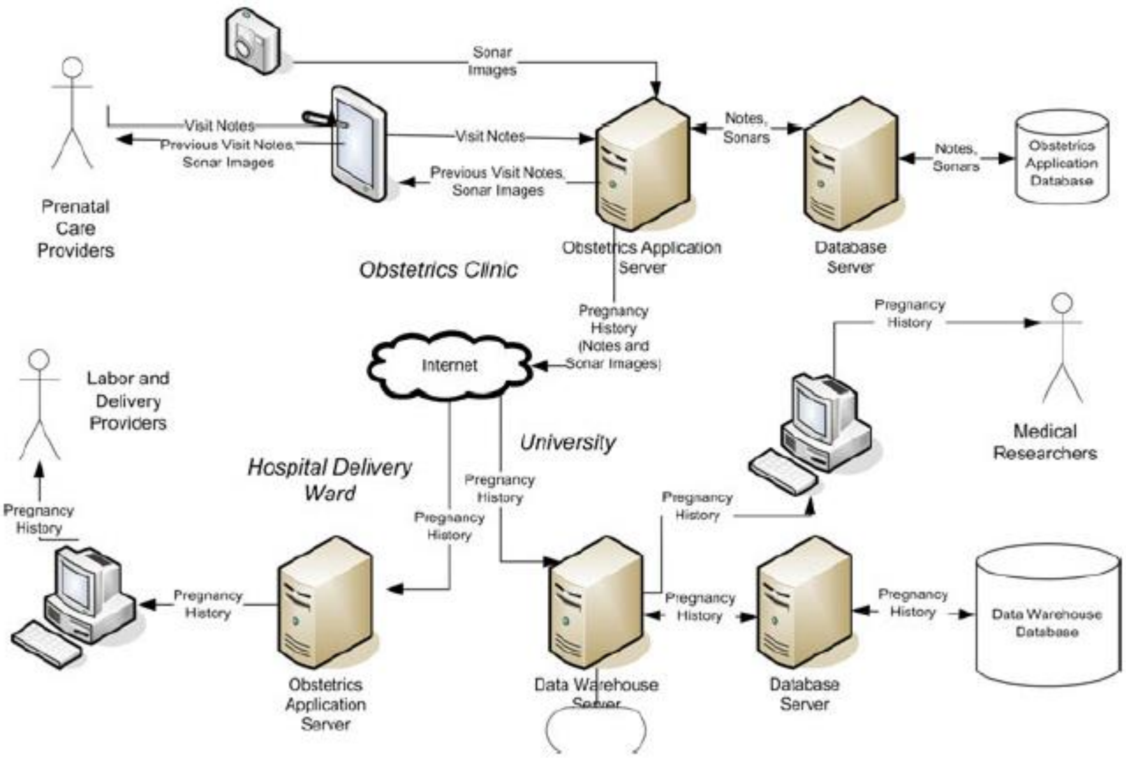


Fig. 9.5 Enterprise architecture diagram of sample obstetrics system

Image taken from:

Murphy, S. N., Klann, J. G., & Meeks-Johnson, J. (2016). Ch. 9: Information Technology Systems. In Finnell, J. T. *Clinical informatics study guide: Text and review* (1st ed.). Cham: Springer International Publishing. doi:10.1007/978-3-319-22753-5

Appendix C

Table 9.2 Network layers of the International Standards Organization (ISO) model

Layer	Name	Description and examples
7	Application	The application layer defines the message format between computer systems or the human-machine interface. Examples are HTTP for web browsers or HL7 for communicating health information between servers.
6	Presentation	The presentation layer handles encryption and compression of data packets. Examples are SSL encryption, ASCII text or JPEG images.
5	Session	The session layer performs authentication, authorization and session restoration. An application connects to a session via a socket, which is assigned by port number.
4	Transport	The transport layer provides end-to-end error control, since data may pass over many physical layers and routers between ends. TCP is a common transport layer protocol. When combined with an IP Address, TCP/IP is the transport method used by the Internet.
3	Network	The network address is an external (unique globally) or internal (unique within the enterprise) address assigned by the network, such as an Internet Protocol Address (IP Address). The network layer connects via routers.
2	Data Link	The data link layer performs error detection and flow of control on the physical link, i.e., controls which end is transmitting and which is receiving. This layer uses physical device addresses known as Media Access Control (MAC) addresses. Each networked device has a unique MAC that does not change if you move the device to a different part of the network. Ethernet is a common data link protocol. The data link layer connects via switches.
1	Physical	Physical medium, such as copper wire, optical fiber or wireless radio transmission. Physical segments connect via hubs.

Image taken from:

Murphy, S. N., Klann, J. G., & Meeks-Johnson, J. (2016). Ch. 9: Information Technology Systems. In Finnell, J. T. *Clinical informatics study guide: Text and review* (1st ed.). Cham: Springer International Publishing. doi:10.1007/978-3-319-22753-5

Appendix D

Analyzing Stage:

- Why does JLR need this system?
- What is the problem JLR is trying to solve?
- How will it improve the care we deliver to our patients?
- Is there data to support the need?
- Can the system JLR already has be configured to meet the need or solve the problem?
- What are possible impacts on patient safety?
- Could it potential change the clinician’s current workflow?
- Does it have the potential to save money?
- What is the estimated cost? Initially and ongoing?
- Does it have the potential to save time or streamline a workflow process?
- What is the risk to JLR if this CIS is not implemented?
- How can those risks be mitigated?
- Does this system support the strategic plan of the company?

Appendix E

Inventory:

How is data stored?

Is it stored in structured or unstructured formats? How is data extracted, transformed, and loaded (ETL)? If structured data, which format is used: XML, JSON, or CSV? The gold standard for database storage for relational databases is Structured Query Language (SQL). However, common relational database brands such as Microsoft, Oracle, and Progest (freeware) have advanced this standardization. Which of these brands is being used? Does a schema design or Entity Relationship Diagram (ERD) exist for databases? Do atomicity, Consistency, Isolation, and Durability (AICD) principles exist in the database operation structures? Are non-relational databases (Nosql) in use (MUMPS, MapReduce, Document, Graph databases)?

How is data used?

Is data used for quality improvement, public health reporting, research, or clinical trial recruiting? Do systems of Knowledge Discovery and Data Mining (KDD) exist presently?

What is the Network Topology?

How are networks and subnetworks organized within the informational technology (IT) department and the organization? Does a star, backbone, ring, or hybrid topology exist? In terms of the 7-layer Open Systems Interconnection (OSI) network model of the International Standards Organization (ISO), how are networks categorized? What are the main components of the network architecture? Does a network Architecture Diagram exist? How does the application and software architecture compliment the network component? What are the non-functional requirements? Define usability, reliability, response time, maintainability, security, disaster recovery, and the cost of a system.
What are the common interface components and languages (HL7, CDA, CCD, and FHIR message protocols)?

Software and Computer Languages

Software development is run directly on the computer with personal user interface or in the application server layers. Database programming refers subprograms that process data such as loading patient records, pulling up appointment schedules, or analyzing quality control. Which object-oriented programs are utilized (Java, C++, C#, Ruby)? What types of procedural programming languages are utilized (Python, PHP)? Scripts are short programs that control the functionality of other programs, especially web pages. How are scripts being employed? What is the software development methodology (waterfall, iterative)? How is developed software tested, verified, and validated? What platforms are preferred for operating systems (Windows, Macintosh, or Unix), data platforms (Oracle or SQL Server), and web browsers (Google Chrome, Microsoft Internet Explorer, Safari, Firefox)? What system of Access Control is used for authentication and authorization? How is security and HIPAA compliance administered?

Sengstack, P. (2016). Ch. 12: Information system lifecycles in health care. In Finnell, J. T. *Clinical informatics study guide: Text and review*. New York: Springer International Publishing. doi:10.1007/978-3319-22753-5

Appendix F

ADU NAP CAPSTONE PROJECT – INFORMED CONSENT

Our names are **Jon Christophersen & Shawn Sturgis**, and we are MSNA students in the Nurse Anesthesia Program (NAP) at Adventist University of Health Sciences (ADU). We are doing a Capstone Project called **iJLR: an ergonomic intervention**. This project is being supervised by Alescia L. DeVasher Bethea, PhD, CRNA. We would like to invite you to participate in this project. The main purpose of this form is to provide information about the project so you can make a decision about whether you want to participate.

WHAT IS THE PROJECT ABOUT?

The purpose of this project is to collect the necessary informational, technological architecture of JLR and Florida Hospital in order to present a satisfactory proposal to a group of key stakeholders of JLR leadership for the undertaking of a mobile application for the JLR anesthesia practitioner.

WHAT DOES PARTICIPATION IN THIS PROJECT INVOLVE?

Participation in this project is twofold. First, data collection will be conducted through a qualitative and descriptive interview process with the time parameter of approximately 60 minutes at the location of Florida Hospital South Campus or at the JLR corporate office. Second, the participation in the JLR mobile application proposal will require attendance to the presentation, and the completion of an anonymous feedback form. Attendance at the presentation and completion of the survey is anticipated to take approximately 60 minutes at the JLR corporate office.

WHY ARE YOU BEING ASKED TO PARTICIPATE?

You have been invited to participate because you serve as a key stakeholder in the informational technology architecture of the corporate JLR system serving Florida Hospital. Participation in this project is voluntary. If you choose not to participate or to withdraw from the project, you may do so at any time.

WHAT ARE THE RISKS INVOLVED IN THIS PROJECT?

Although no project is completely risk-free, we do not anticipate any harm or distress by participating in this project.

ARE THERE ANY BENEFITS TO PARTICIPATION?

We have no expectation of any direct benefits from the participation in this project. The possible indirect benefit of participation in the project is the opportunity to gain additional knowledge and possible feedback to the development of a JLR mobile application.

HOW WILL THE INVESTIGATORS PROTECT PARTICIPANTS' CONFIDENTIALITY?

The results of the project will be published, but the names and identities of participants will not be revealed. To maintain confidentiality of the feedback forms, the researchers will conduct the interviews and feedback of the proposal in such a way to ensure that information is submitted without participant's identification. The participants of the proposal presentation will be asked not to include any identification on the feedback forms.

WILL IT COST ANYTHING OR WILL I GET PAID TO PARTICIPATE IN THE PROJECT?

Your participation will cost approximately 60 minutes of your time. No monetary cost is required. Also, you will not be paid to participate.

VOLUNTARY CONSENT

By signing this form, you are saying that you have read this form, you understand the risks and benefits of this project, and you understand the undertaking of participation in this research and proposal. The investigators will be happy to answer any questions you have about the project. If you have any questions, please feel free to contact Jon Christophersen at email address: Jonathan.Christophersen@my.adu.edu or Shawn Sturgis by at email address: Shawn.Sturgis@my.adu.edu. If you have concerns about the project process or the investigators, please contact the Nurse Anesthesia Program at (407) 303-9331.

____ ________________

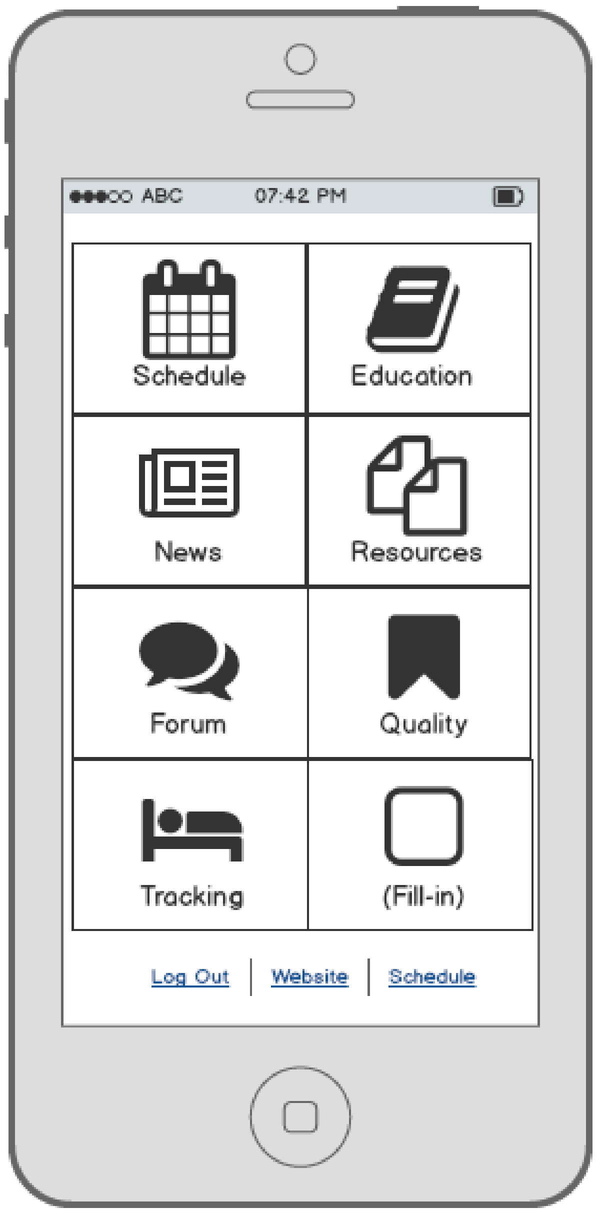
Participant Signature Date

____

Participant Name (PLEASE PRINT LEGIBLY)

Appendix G

Example of Application Design Wireframe:



Appendix H

Proposal (Suggested RFP elements):

- An introduction and purpose statement
- A brief description of the scope
- Abbreviations and terminology used
- The RFI/RFP procedure:
  - How the potential solution should be delivered
  - Who in the organization will direct communications
  - Location and time frame
- Background description of the solution
  - Description of the project
  - Description of the product services being requested
  - Statement of the need
  - System requirements both technical and functional
- Proposed project solutions
- Criteria for how the proposal will be evaluated by the organization (RFP)
- Pricing or estimated costs – initially and ongoing
- Support needed for the CIS – initially and ongoing
- Description of business continuity management
- Description of products or services that are already delivered to customers today, and could be comparable to what is being requested

Office of the National Coordination for Health IT (2013). Request for Proposal (RFP) template for HIT. Retrieved from: http://healthit.gov/node/891. Accessed on April 3, 2016.

Appendix I

JLR Mobile App Proposal
Feedback Form

For questions 1 – 2, circle one of the following three choices in response to the question:

1. **Does JLR and/or USAP have a long-term plan for such mobile technology?**

   YES NO I DON'T KNOW

2. **If you answered NO above, are you interested in adding this type of technology into your long-term plan?**

   YES NO I DON'T KNOW

For questions 3 – 6, circle one number from the scale of 1 – 5 based upon your opinion.

3. **Do you think the proposed mobile app will address gaps in features/functions in your current solution(s) at JLR and/or USAP?**

   (Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

4. **Does this proposal fit well with JLR and/or USAP's IT vision of the future?**

   (Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

5. **After this presentation are you more likely to pursue creating a mobile app with the proposed features/functions?**

   (Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

6. **Will the mobile app provide immediate value/benefits to the employees and/or organization?**

   (Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

For questions 7 – 9, please provide a written response based on your opinion of the proposal.

7. **Which feature/function proposed would you deem the highest priority?**

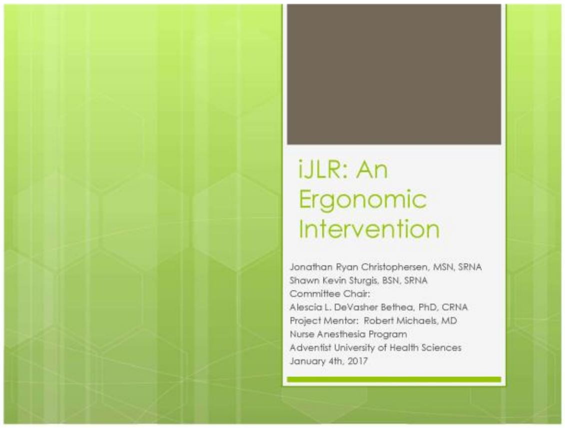
   ____

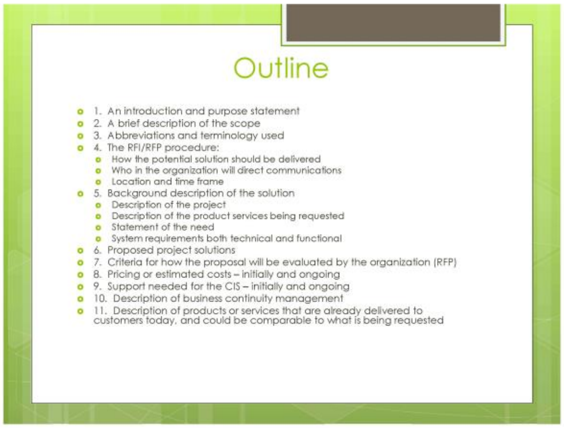
   ____

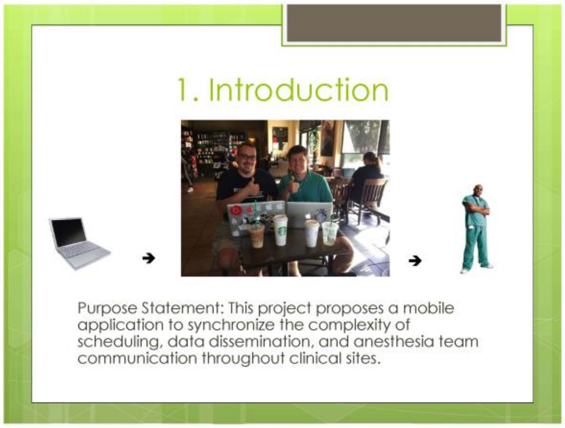
8. **Which feature/function proposed would you deem the lowest priority?**

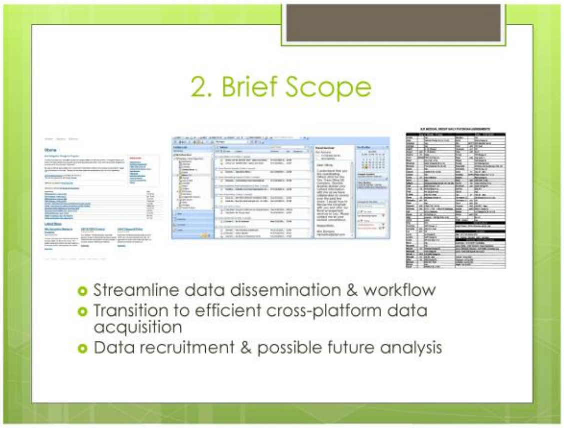
9. What additional features/functions would you add to the mobile app?

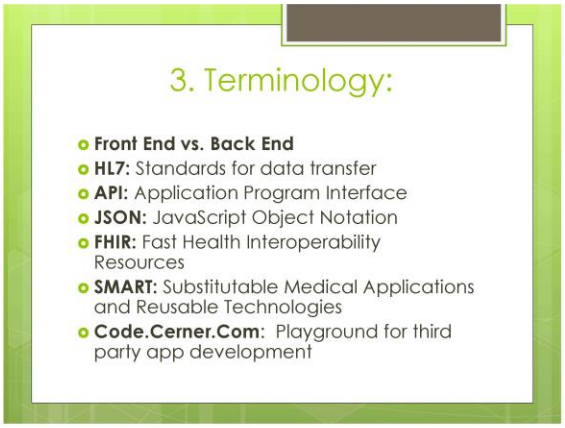
Appendix J


iJLR: An Ergonomic Intervention
Jonathan Ryan Christophersen, MSN, SRNA
Shawn Kevin Sturgis, BSN, SRNA
Committee Chair:
Alescia L. DeVasher Bethea, PhD, CRNA
Project Mentor: Robert Michaels, MD
Nurse Anesthesia Program
Adventist University of Health Sciences
January 4th, 2017


Outline
1. An introduction and purpose statement
2. A brief description of the scope
3. Abbreviations and terminology used
4. The RFI/RFP procedure:
How the potential solution should be delivered
Who in the organization will direct communications
Location and time frame
5. Background description of the solution
Description of the project
Description of the product services being requested
Statement of the need
System requirements both technical and functional
6. Proposed project solutions
7. Criteria for how the proposal will be evaluated by the organization (RFP)
8. Pricing or estimated costs – initially and ongoing
9. Support needed for the CIS – initially and ongoing
10. Description of business continuity management
11. Description of products or services that are already delivered to customers today, and could be comparable to what is being requested

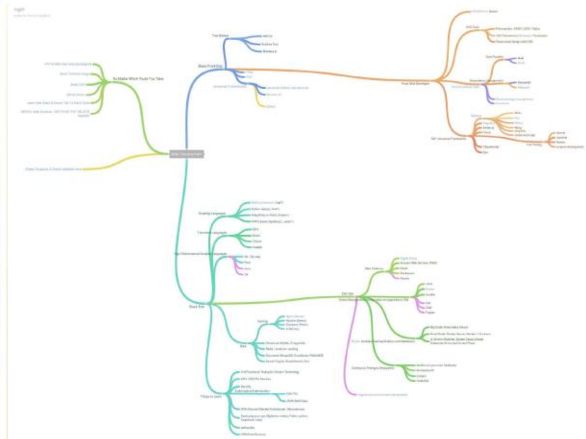

1. Introduction
Purpose Statement: This project proposes a mobile application to synchronize the complexity of scheduling, data dissemination, and anesthesia team communication throughout clinical sites.

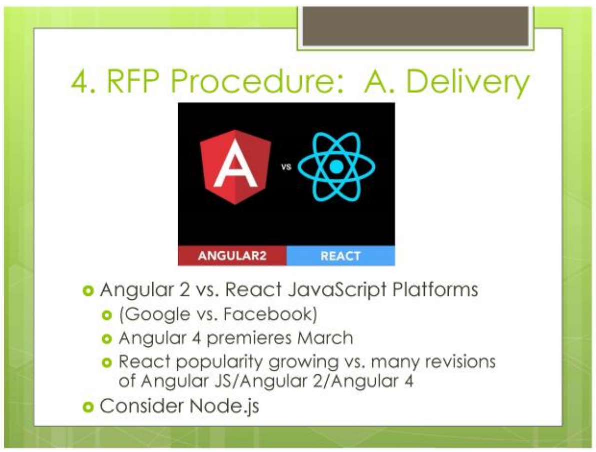

2. Brief Scope
Streamline data dissemination & workflow
Transition to efficient cross-platform data acquisition
Data recruitment & possible future analysis

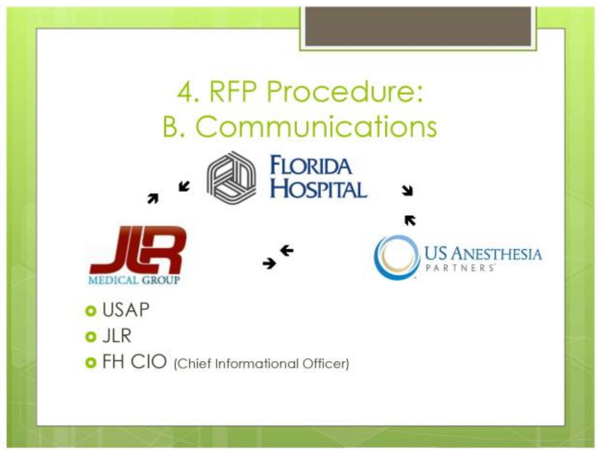

3. Terminology:
Front End vs. Back End
HL7: Standards for data transfer
API: Application Program Interface
JSON: JavaScript Object Notation
FHIR: Fast Health Interoperability Resources
SMART: Substitutable Medical Applications and Reusable Technologies
Code.Cerner.Com: Playground for third party app development

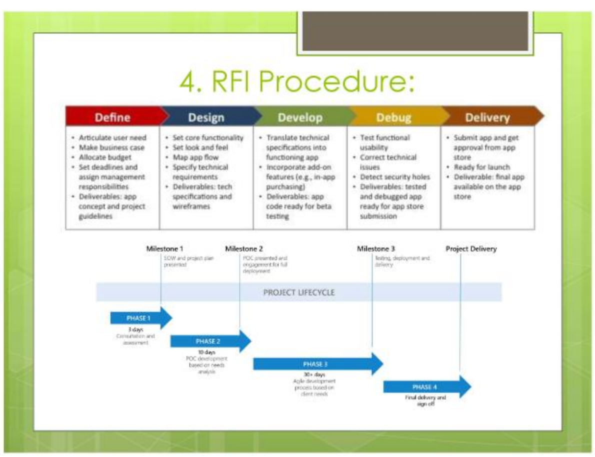

3. The Technological Milieu
HL7 FHIR
The Argonaut Project Sponsors:
Accenture
athenahealth
Beth Israel Deaconess Medical Center
Cerner
Epic
Intermountain Healthcare
Mayo Clinic
MEDITECH
McKesson
Partners HealthCare System
SMART at the Boston Children's Hospital Computational Health Informatics Program
The Advisory Board Company
Surescripts
SMART
App running on a single patient's data in a web browser
End-user dashboard (optional implementation feature)
End-user selection
Locally curated selection
Gallery of locally available apps
SMART API
SMART public app exchange
SMART container (eg. EHR, PCHR or HIE)
Container
Native data store or distributed data sources
(ESTABLISHED 2009)


3. The Technological Milieu
• Code.cerner.com allows a developer to test conceptual applications against a safe sandbox databank for development.
• Documentation and development is ongoing including the anticipated **appointment** module.
Cerner | code
(Established 2/2016)
Verb | Description
GET | Used for retrieving resources.
POST | Used for creating resources.
PUT | Used for updating resources.
Overview
Authorization
Conformance Metadata
AllergyIntolerance
Appointment
Condition
Contract
Device
DiagnosticReport
DocumentReference
Encounter
Immunization
MedicationOrder
MedicationStatement
Observation
Patient
Person
RelatedPerson
https://fhir-open.sandboxcerner.com/dstu2/d075cf8b-3261-481d-97e5-ba6c48d3b41f/:resource[?:parameters]




4. RFP Procedure: A. Delivery
VS
ANGULAR2
REACT
Angular 2 vs. React JavaScript Platforms
(Google vs. Facebook)
Angular 4 premieres March
React popularity growing vs. many revisions of Angular JS/Angular 2/Angular 4
Consider Node.js


4. RFP Procedure: B. Communications
FLORIDA HOSPITAL
JLR MEDICAL GROUP
US ANESTHESIA PARTNERS
USAP
JLR
FH CIO (Chief Informational Officer)


4. RFI Procedure:
Define
Design
Develop
Debug
Delivery
• Articulate user need • Make business case • Allocate budget • Set deadlines and assign management responsibilities • Deliverables: app concept and project guidelines
• Set core functionality • Set look and feel • Map app flow • Specify technical requirements • Deliverables: tech specifications and wireframes
• Translate technical specifications into functioning app • Incorporate add-on features (e.g., in-app purchasing) • Deliverables: app code ready for beta testing
• Test functional usability • Correct technical issues • Detect security holes • Deliverables: tested and debugged app ready for app store submission
• Submit app and get approval from app store • Ready for launch • Deliverable: final app available on the app store
Milestone 1
Milestone 2
Milestone 3
Project Delivery
PROJECT LIFECYCLE
PHASE 1
PHASE 2
PHASE 3
PHASE 4


5. Background Description of Solution: Why the need?
NEWS

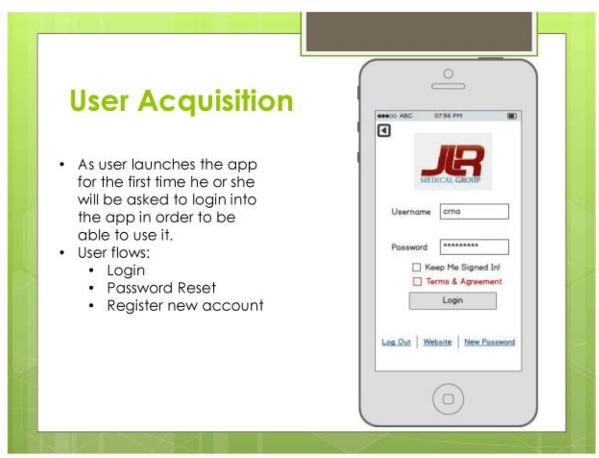

6. Project Solution
Schedule
Quality
News
Resources
Forum
Education
Tracking
(Fill-in)
Charting Error
CRNA needed at South
Database Complete
Shift Swap Fulfilled
Insurance Form Completed
Log Out | Website | Schedule


6. Project Solution
Integrated Multipurpose Mobile Application
Team members can easily navigate:
Scheduling, location, clinical site information
Surgeon preference
Link to patient quality forms
Easily accessible contact information


6. Project Solution (continued)
Advantages
Streamline communications reducing individualized texts and emails
Communicate team leaders via push messages
Instantly update all team members
Real-time case schedule calendar view
Automate schedule swapping reducing redundant emails
Possible data analysis
Future remote clinical coordination?!?!?


Mobile App Technical Approach
Mobile applications will communicate with a web server through the REST API that will be developed in terms of this project as well.
Initial development may accommodate mobile webpage formats (i.e. Angular 2)


Mobile App Technical Approach
Android application will be developed using Android SDK(Software Development Kit) and additional 3rd party libraries (data modeling, http requests, database managing etc.).
iOS application will be developed using default Apple's Cocoa Touch SDK. Alamofire Cocoa Pod may be used for web server communication.


User Acquisition
As user launches the app for the first time he or she will be asked to login into the app in order to be able to use it.
User flows:
Login
Password Reset
Register new account
JLR MEDICAL GROUP
Username crna
Password *********
Keep Me Signed In!
Terms & Agreement
Login
Log Out | Website | New Password

Cases

- API real-time data retrieved from Cerner will allow consistent scheduling matches paired with daily schedules
  - Know when to show up for demanding cases
- Surgeon Preferences
- Quality Control Integration

Surgeon Details

- After selecting a case user will be navigated to the screen with detailed info about the case
- User flows:
  - Preview case information
  - Edit a case comments
  - Future Project of Dr. Rosemeier

Contacts

- Contacts screen will represent a list of contacts with brief information about the person and ability to call/message him or her.
- No need for cumbersome contact lists or Jimmy John's contact info.

Settings

- Mobile users will have an ability to enable/disable PUSH notifications.

Help & Support

- Help & Support screen will help user to understand of how the app can be used. It may also contain an FAQ section.
- Other than that there will be an ability to request help from a support team by filling in the form.

7. Criteria for Evaluation

- SMART Platform for testing
- Dataset validation of app-specific needs
- FHIR resources completion
- FHIR calls in real-time versus database storage
- Cost versus benefit
- Continual need

Load testing

- An estimated 40 requests per second would allow for 3 million requests per day in peaks
- Jmeter would be utilized to test load performance

Volume testing

- According to target volume loading database must support 200,000 users, and this amount will be growing with years. In addition, database must support about 1 million new cases per month. (120 million during 10-year period).
- We are supposing that one server can solve target loading but require
  - a) For increasing loading performance:
    - - Using aggressive caching modules (for example memcache)
    - - Disabling of unused modules
    - - Optimization of custom PHP code and SQL requests
    - - Buy more powerful server (not sure, need to know current server configuration).
  - b) For supporting target amount of data:
    - - Code and theme optimization
    - - Optimization of SQL requests

Volume testing

- These steps allow increasing server performance up to 5 million requests per day and support target 200,000 users and 1 million new cases per month.
- Increasing loading more than 5 million requests per day will require moving the whole system from one server to the cloud with multiple servers with loading balance. This will not require additional coding but will cost 2 additional servers for load balancing and database cluster control, additional administration and configuration, and one additional server per additional 4 million requests per day.

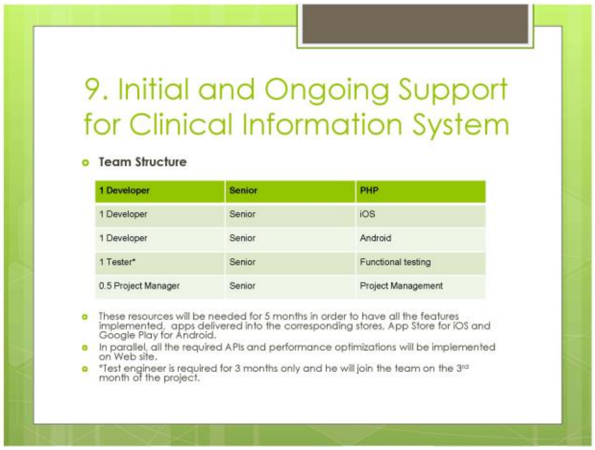
8. Estimated Costs for Completion

Task Description	Est. effort, hrs.
General	
Application skeleton	8
Side menu	6
Detecting data models and relations between them	16
Data persistance	16
Push notifications	16
Server communication	16
Google Analytics integration	8
User acquisition	
Login	8
User Profile	16
Reset password	8

Task Description	Est. effort, hrs.
Cases	
API Integration	12
Filter/category selector	6
Case details	16
Clinician Schedule API Interface	16
OR Schedule	32
Case Modification	16
Selected case	
Screen UI	4
List of participants	8
"Edit mode"	16
Interactive OR Boards	8

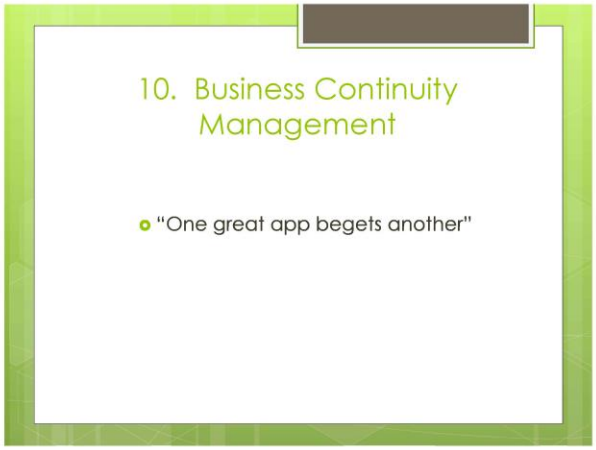
Task Description	Est. effort, hrs.
Participant view	
Screen UI	8
Send a message	4
Call	1
Quality Control Integration	
Case history	8
Statistical Profiling	16
Database Management	16
API Build	8
Messages	
List of messages	16
Write new message	10
Messages screen UI	16
Blocked users	10

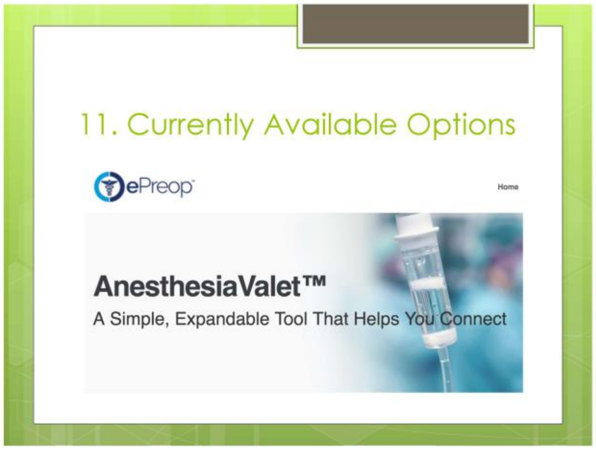
Task Description	Est. effort, hrs.
Contacts	
Screen UI	6
List of contacts	8
Pending contacts	8
Sent requests	8
Invite a colleague	12
Help & Support	16
Settings	16
Total	**439**
	* this estimate is per 1 mobile app
	for Android + iOS it is 439*2 = 878


9. Initial and Ongoing Support for Clinical Information System
Team Structure

1 Developer	Senior	PHP
1 Developer	Senior	iOS
1 Developer	Senior	Android
1 Tester*	Senior	Functional testing
0.5 Project Manager	Senior	Project Management

These resources will be needed for 5 months in order to have all the features implemented, apps delivered into the corresponding stores, App Store for iOS and Google Play for Android.
In parallel, all the required APIs and performance optimizations will be implemented on Web site.
*Test engineer is required for 3 months only and he will join the team on the 3rd month of the project.


10. Business Continuity Management
"One great app begets another"


11. Currently Available Options
ePreop
Home
AnesthesiaValet™
A Simple, Expandable Tool That Helps You Connect