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### Improving Clinical Communication and Collaboration Through Technology

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Improving Clinical Communication and Collaboration Through Technology

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October 1, 2020

### Acknowledgements

Nothing I have achieved with this Doctorate would have been possible without the support of the Northern California Nurse Scholars Academy (NSA), so the first acknowledgement and sincere thanks rightly go to Kaiser Permanente and the NSA programs.

My thanks to Kaiser's SVP Linda Knodel for involving me with clinical communication in 2018, and to my very valued colleagues, Dr. Anne Marie Watkins, Dr. Janet Sohal, Debbie Reitter, RN, MSN, CNS, and Sherri Cox DNP(c) for their knowledge and support.

I was completely terrified when told Dr. Mary Lynne Knighten was my Chair, as my first semester in her class had not gone as smoothly as I had hoped for. Yet, I could not have been luckier, as Dr. Knighten has been the most wonderful support and has provided the level of academic rigor and guidance that every DNP student can only *dream* of. It was an honor and privilege to be mentored by her, and to publish with Dr. Knighten and Dr. Sohal on this topic.

No acknowledgement would be complete without the obligatory (and very heartfelt) thanks to friends and family. I started this DNP houseless and husbandless, challenging times indeed. Our house was uninhabitable, and my husband's green-card had no signs of being issued; therefore, he could not enter the United States. My enduring love and thanks to the Wilsons and the Brosnahans for giving me a bed to sleep in, a table to work on, love, support, and a place to cook baked beans on toast (because that is all I can cook!). You guys *are* family. For my wonderful Mom, Thelma – maybe now you do not have to worry about me anymore? Ciara, you got to your master's degree 15 years earlier than I got to it, you didn't lick it off the ground kiddo! I could not be any prouder of you than I am. When are you starting your Doctorate? Last but definitely not least, to my darling husband, who has now suffered through three degrees over 17 years. None of this could have been done without you, and all of it is dedicated to you.

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### **Section I: Abstract**

**Problem:** Over the last 30 years, clinical communication methodologies in healthcare have evolved to become such disparate systems that they lead to confusion, wasted time, and clinician dissatisfaction. The Joint Commission (2016) reports up to 78% of sentinel events in hospitals are linked to communication failures, which have obvious implications for hospital systems in the quality and safety of their current communication systems.

**Context:** The purpose of this project was to determine the effectiveness of implementing a unified clinical communication technology platform in an acute care hospital setting and to make recommendations from that implementation to the organization's larger health system. Its purpose was also to determine if the creation of a clinical communication technology implementation guide for nurse leaders would positively impact future implementations of such platforms throughout the larger health system.

**Interventions:** This project introduced smartphone communication technologies to inpatient nurses and other clinicians in a 352-bed hospital in California, which is part of a larger 39-hospital, multi-state system. Analysis was then performed by collecting data before and after implementation of the clinical communication platform. While not part of the original plan, elements of the platform were subsequently deployed to help with clinical communication during the height of the SARS CoV (COVID-19) pandemic, and this implementation was also analyzed for the project. The intention was also to determine if the creation of a clinically focused implementation guide for clinical leaders could positively impact the application of such a communication platform throughout the larger health system.

**Measures:** Measures in this study included productivity, efficiency, quality of care, communication, and staff satisfaction with the newly implanted technology. Measurement

regarding the usefulness of the implementation guide was gauged through the perceived satisfaction of nurse leaders who reviewed the guide and gave feedback.

**Results:** Mixed results were realized from the implementation of this technology, but the work yielded valuable information for future implementations within the organization. Frontline staff and physician satisfaction with the whole platform was low, but leadership satisfaction with the elements implemented for COVID-19 was high. For the implementation guide, nurse leaders gave valuable feedback and determined it would be a highly useful document for facility implementation leads in the future.

**Conclusion:** The implementation of new clinical communication technology and methodologies has the opportunity to improve productivity, efficiency, quality of care, communication, and staff satisfaction, but only if barriers to implementation are mitigated before, during, and immediately after go-live. A comprehensive implementation guide for nurse leaders can be the tool designed specifically to mitigate these barriers and prepare nurse leaders and facilities for the new technology and associated workflow changes that accompany the technology.

*Keywords;* clinical communication, leadership, nursing, smart device, smartphone,



## **Section II: Introduction**

In a large, 39-hospital, seven-state, integrated health system in the United States, clinical communication is similar to the disparate systems noted in the literature. Some of the organization's facilities rely on pagers, analog phones, and the overhead paging systems, while others have smart devices and instant secure messaging systems for clinical communication and collaboration (CC&C) among the whole care team. Communication opportunities exist at the macro-, meso-, and micro-system levels of this organization. Current literature demonstrates that clinician satisfaction improves with an optimized communication platform, and quality, patient safety, and care experience are enhanced when communication improves (Menon & Rivett, 2019; VanDusen, 2017; Webb, Spina & Young, 2016). Additionally, workflow efficiencies are realized when communication is enhanced, and there are projected clinical cost savings with the implementation of systems to improve communication (Brooks, 2018; De Grood et al., 2012).

### **Problem Description**

The setting for this project was a large, seven-state, integrated health system in the United States, which has a combination of hospitals, outpatient clinics, and a self-funded health plan. There are 39 inpatient hospitals within three U.S. states in the health system. The macrosystem is disadvantaged by the multitude of different processes. From a national perspective, nursing, physician, and information technology (IT) leadership, seeking to unify communication processes for all clinicians, were preparing a business case to present to the Board of Directors. This frustration was echoed at the mesosystem (facility) level, where clinicians and leadership reported dissatisfaction in those facilities that had older communication methodologies. Six of the 39 hospitals at the mesosystem level have had a newer smartphone platform since 2015, and in the other 33 facilities, nurses were using older analog devices, while physicians were using smartphones and a standalone messaging application for providers only. At the microsystem

level, individual clinicians expressed the same frustration with poor communication among team members, dissatisfaction with outdated technologies, and potential risks in patient care. In the six facilities where the newer technologies had been implemented, no studies had been done on the effectiveness of the solution.

KP Medical Center X (KP-MCX) is a 352-bed inpatient facility with acute care, critical care, perioperative, emergency, and maternal child services (see Appendix A for a full list of the departments in the facility). KP-MCX was the setting for this project and the inpatient units and emergency department (ED) were the last areas to go-live in the current funding cycle. Data collected before and after this implementation was to be added to the business case to seek funding for the remaining 31 hospitals in the health system. At this medical center, most departments were going live with the organizationally branded Integrated Healthcare Communication (IHC) platform which included the Vocera® clinical communication platform. Some were implementing the platform on handheld devices (Zebra® TC51 devices with the Vocera Collaboration Suite [VCS] app) and others were planning to use hands-free devices utilizing VCS on the Vocera badge device (see Appendix B for a list of the departments and the devices they were planning).

Previously in the facility, there were multiple communication methodologies. The nurses used analog Cisco® 7925 phones to make and receive phone calls within the facility. However, they could only call desk phones or other Cisco phones (see Appendix C for a pictorial description of the devices). The only other function of these Cisco phones was to receive cardiac alarm notifications from the cardiac monitoring system and alerts from the Rauland Responder® nurse-call system. These alerts included the nurse-call button, code blue, staff assist calls, and bed-exit alarms. When any member of the team needed to contact someone outside the

department, they went to a desk phone and paged or called the other person. This required them to then wait at the desk for the return call. There was no access to the electronic medical record (EMR) on Cisco phones, and a combination of all of these processes decreased the efficiency of the care team.

Providers used multiple methodologies to communicate with nursing and other care team members. Physicians had employer-provided pagers and Apple iPhones® on which they could receive calls and pager messages. Many providers carried employer-provided Apple iPads® to access and document in the EMR. Providers also had Imprivata's Cortext® secure messaging application on their iPhones to message between physicians and some clinical leaders. Staff nurses could not use Cortext on their Cisco phones, therefore had no access to secure instant messaging with other team members. These multiple communication methodologies led to confusion, wasted time, and inefficiencies in care team collaboration. Because there were no messaging capabilities on the nurse's analog phones, there were also situations where clinicians had anecdotally said that they used their personal phones to send and receive messages to providers and other members of the care team. This was not a process advocated by the organization as it created the potential to cause Health Insurance Portability and Accountability (HIPAA) privacy breach concerns (Freundlich, Freundlich, & Drolet, 2018; Przybylo et al., 2014). Five other KP hospitals in the California region had implemented this technology in the previous five to eight years, and now it was KP-MCX's turn to implement the platform.

### **Available Knowledge**

#### **PICOT Question**

Two PICO(T) questions guided the search for available knowledge and evidence about CC&C in the inpatient setting:

1. For inpatient nurses in a large hospital system (P), does the introduction of smart-device communication strategies (I), compared to no smart-devices (C), have a positive effect on productivity/efficiency, quality of care, and communication (O) within a six-month period post go-live (T)?
2. For inpatient nurse leaders (P), could a technology implementation guide for clinical facility leads and chief nurse executives (I), compared to no guide (C), positively impact the implementation of a smart-device communication platform in their hospitals (O)?

### **Search Methodology**

The Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, Scopus, and Cochrane databases were searched using the key terms *clinical communication*, *secure messaging*, *mobility*, *smartphone*, *smart device*, *leadership* and *nursing*. Given the literature search sought evidence worldwide, the key terms utilized included nomenclature more familiar in other countries including *smart device* and *mobile phone*. As there are public and private industry leading experts in unified clinical communications, a Google® search using the same key terms also contributed to the body of knowledge from expert opinions and government organizations. Inclusion criteria allowed for literature that provided information about communication from other healthcare team members, not just nursing. Exclusion criteria included published bodies of knowledge about clinical communication older than 15 years, as well as non-inpatient related communication methodologies and technologies. A total of 136 articles and expert opinions were identified in the literature review. These were reduced to approximately 60 that were included in the reference section. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram was utilized to screen articles and to determine eligibility for inclusion (Moher, Liberati, Tetzlaff, & Altman, 2009; see

Appendix D for the PRISMA flow diagram). From the sixty articles considered suitable to be utilized throughout the document, thirteen were deemed appropriate to be included in the evidence table. In reviewing the articles for strength and quality, the Johns Hopkins Nursing (2017a, 2017b) appraisal tools were used, with permission (see Appendix E and Appendix F). This provided guidance for the research (qualitative, quantitative, mixed methods), and non-research articles that became the table of evidence. After appraisal, using the Johns Hopkins tool, the quantitative and qualitative evidence ranged from Level 1-A to Level III-B, and the non-research evidence was determined to be Level V-B (good quality). See Appendix G for a critical appraisal of key elements of the evidence.

### **Review of the Evidence**

In 2007, the Institute for Healthcare Improvement published the Triple Aim, a framework that guides healthcare practice, research, education, and policy, with three goals: (a) improving care experience, (b) improving population health, and (c) reducing healthcare costs. (Bodenheimer & Sinsky, 2014). In 2014, this became the Quadruple Aim, when clinician satisfaction was added as the fourth element. This provides an excellent framework for the type of improvements that could be realized if clinical communication is improved.

The Center for Health Information and Decision Systems notes that hospitals in the United States waste over \$12 billion annually due to communication inefficiencies among healthcare providers (Agarwal, Sands, & Schneider, 2019). The average U.S. 500-bed hospital loses over \$4 million annually due to communication inadequacies, resulting in longer lengths of stay, delays in clinician contact, absence of standardized workflows, poor alarm/alert management, high cognitive burden, lack of information in clinicians' hands, fragmented clinical directories, missed escalation opportunities, and the inability to know what staff were on duty

(Agarwal et al., 2019; Higgins et al., 2017; Ponemon Institute, 2014). Additionally, the literature demonstrates inefficient resource utilization, ineffective core operations, slower inpatient admission times, doubled emergency response times, avoidable admissions and readmissions, and decreased patient and staff satisfaction; all of which impact healthcare quality and patient safety (Agarwal et al., 2019; Higgins et al., 2017; Ponemon Institute, 2014). With 19% of nurses' time spent communicating (Chatterjee, Chakraborty, Sarker, Sarker, & Lau, 2008), the importance of an adequate CC&C platform cannot be over-emphasized. Enabling clinicians to communicate more effectively will help organizations achieve the Quadruple Aim, as well as meet this health system's mission to provide high-quality, affordable healthcare services.

Healthcare is in an era where efficiency, access to information, and improved communication methodologies are becoming as vital to the performance of our nursing role as the skills described by Florence Nightingale "to provide a safe and caring environment that promotes patient health and wellbeing" (Selanders & Crane, 2012, p. 1). Tools that provide HIPAA compliant secure messaging; smartphones with voice, messaging, and group chat capabilities; wearables that allow hands-free communication; and devices that host a variety of useful clinical applications are examples of these types of technologies in healthcare. Also, processes that lead to standard work, including standardizing clinical communication, provide "higher reliability, better care, and improved patient outcomes, eliminate non-value-added waste, and optimize existing value resulting in reduced errors, improvements in quality, and reduced burden of work for staff" (Boettcher, Hunter, & McGonagle, 2019, p. 152).

The general benefits of smartphones, mobile platforms, and messaging methodologies in healthcare are well documented in academic literature and general publications (Bautista, Rosenthal, Lin, & Theng, 2018; Brooks, 2018; Martin et al., 2019; Mickan, Atherton, Roberts,

Heneghan, & Tilson, 2014; Motulsky et al., 2017; Patel, Siegler, Stromberg, Ravitz, & Hanson, 2016; Runyon, 2018; VanDusen, 2017; Whitlow, Drake, Tullman, Hoke, & Barth, 2014).

However, when we look at quality and safety benefits, the literature is specific. Tethering clinicians to landlines, emails, pagers, and intercoms through lack of a mobile device causes quality and safety problems: such as care delays, decreased throughput, and potential medical errors (Brooks, 2018; Patel et al., 2016). The introduction of smartphones has been associated with enhanced interprofessional communication (Martin et al., 2019; Patel et al., 2016; VanDusen, 2017), improved handoffs, faster response times, less disruption to clinical workflows, improved interprofessional interactions, and reduction in redundant tasks and care delays (Brooks, 2018; Martin et al., 2019). The ability to access information for clinical guidance, policies, and improved clinical decision-making has also been noted (Mickan et al., 2014).

In a deductive study, which reviewed the literature around the use of mobile devices in healthcare, Chatterjee et al. (2009) reported a reduction in delays in healthcare services and an improved ability to monitor critically ill patients. Quality of care was enhanced through the diagnosis of pediatric skin conditions when pediatric images were transmitted by smartphones (Devrim et al., 2019) and through a significant rise in electronic prescribing (from 53% to 64%) and better clinical decision-making (Brown-Manhertz, 2017). Motulsky et al. (2017) demonstrated a 51% increase in accuracy in handoffs for all units with the introduction of a smartphone handoff and rounding tool. De Grood et al. (2012) reported that their wireless communication device implementation “did live up to its aims of enhancing communication, staff efficiency and improving perceived patient safety” (p. 154). Astarcioglu et al. (2015) described a door-to-balloon time improvement of 16% (21 minutes faster) after implementing a

messaging application. Jeon and Park (2015) found that mobile interventions in nursing led to significant improvement in weight and glucose control among their patients. Multiple authors reported the time savings of a clinical communication platform (Agarwal et al., 2010; Breslin, Greskovich & Turisco, 2004; Mehrzad & Barza, 2015; Menon & Rivett, 2019; Vermeir et al., 2015; Whitlow et al., 2014). Within the scientific underpinning of practice context (American Association of Colleges of Nursing [AACN], 2006), it is worth relating these findings to Aiken, Clarke, Sloane, Sochalski, and Silber's (2002) study, which demonstrated that in hospitals with over-burdened nurses, the risk-adjusted 30-day mortality is higher, as is nursing burnout and job dissatisfaction.

Menon and Rivett (2019) conducted a mixed methods study, including time and motion studies, interviews, and a survey, which demonstrated efficiencies in discharge patient flow, improvement in speed of getting discharge medications to nurses (by 10 minutes), and reduction of medication errors after the introduction of a messaging system in their organization. One organization reduced ED utilization in their opioid-seeking population by 73% by using their clinical communication platform to alert staff when those patients presented to the ED. However, as Brooks (2018) stated in this expert opinion, "More important, the (ED) care managers were able to refer these patients to the opioid-abuse rehabilitation and behavioral health resources they needed" (p. 5).

Other enhancements included real-time access to clinical information reduced ED visits and inpatient bed utilization, improved organization of daily activities, improved care coordination, and improved clinician satisfaction (Brooks, 2018; Mickan et al., 2014; Patel et al., 2016; VanDusen, 2017). Finally, improvements in rounding, handoffs, and collaborative documentation practices were reported in a quantitative study by Motulsky et al. (2017). These



improvements all lead to the improved quality and safety of patients, which is necessary to meet Essential II of The American Association of Colleges of Nursing's 'Essentials of Doctoral Education for Advanced Nursing Practice' which discusses doctorally prepared nurses improving organization and systems leadership for quality improvement and systems thinking (AACN, 2006).

From a quality and safety perspective, no communication platform is without concerns. HIPAA violations, risk of distractions, usability and task load, appropriate use, form factor (shape), legal issues, sound quality, the *myth of dependability*, and the potential for worsening relationships have all been documented in the literature (Al Thomairy, Mummaneni, Alsalamah, Moussa, & Coustasse, 2015; Chari & Gane, 2018; Drews, Zadra, & Gleed, 2018; Gill, Kamath, & Gill, 2012; Health Information Management and Systems Society, 2018; Hughes-Driscolla, Gurmub, Azeem, & El Metwally, 2018; Kuhlmann, Ahlers-Schmidt & Steinberger, 2014; Lo, Wu, Morra, Lee, & Reeves, 2012; Maryn, Ysenbaert, Zarowski, & Vanspauwen, 2017; McBride, 2015; Redelmeier & Detsky, 2013; Ross & Forgie, 2012; Thomas, 2013). These are concerns that must be addressed in any communication platform implementation, due to their potential effect on the quality and safety of patient care.

The evidence clearly demonstrates that care-quality improves with enhanced clinical communication. This project asked if the introduction of smartphone communication strategies would have a positive effect on productivity/ efficiency, quality of care, and communication for inpatient nurses in a large hospital system within a six-month period post go-live. The PICOT question was not met in this facility compared to other implementations described in the literature, however it is believed that the learnings taken from the go-live in KP-MCX will help other hospitals within the health system.

## **Rationale**

The conceptual framework from three theories guided this project. Rogers' diffusion of innovation theory (Doyle, Garret, & Currie, 2014), Klein and Sorra's (1996) implementation framework, and Michel-Verkerke and Spil's (2013) USE IT-adoption-model represented the concepts demonstrated with this technology implementation.

Rogers (as cited in Doyle et al., 2014) originally developed the diffusion of innovation theory in 1962 in two categories. First, Doyle et al. (2014) discussed adoption of innovation at the individual and organization level. At the adoptee level, Rogers categorizes people as being either innovators, early adopters, early majority, late majority, or laggards. Doyle et al. further described the five stages of innovation as knowledge, persuasion, decision, implementation, and confirmation. This was particularly important in the development of an implementation guide for staff receiving the communication platform and helped address the concerns of the laggards, while harnessing the enthusiasm of the innovators and early adopters.

Klein and Sorra's (1996) implementation model detail a process that determines the effectiveness of an innovation implementation in an organization. How well an innovation is adopted is a result of the organization's climate and the organization's employees' perceptions of the fit of the innovation within the organization's values. This communication platform will eventually be implemented in 33 hospitals in three different U.S. states, so making the best effort to know the meso and micro-systems culture, their values, and the climate will be important.

Michel-Verkerke and Spil's (2013) USE IT-adoption-model also predicts and evaluates the adoption of innovations; specifically, information system (IS) innovations in healthcare. There are four determinants to the success of the adoption of IS systems: relevance,

requirements, resources, and resistance. In this model, the determinants are measured both organizationally and at the individual (end-user) level (Michel-Verkerke & Spil, 2013). This organization previously had some difficult large-scale IT implementations in recent years, so integrating the four elements of the USE IT-adoption model helped to assess the organization's readiness and control these challenges and ultimately, was utilized to assess the success of this communication platform implementation.

### **Specific Aims**

The aim of this project was to develop, implement and evaluate a clinical communication program by providing expert information to the leadership of a national health system as they move forward utilizing technology to improve clinical communication. The project determined the effectiveness of the implementation of a unified clinical communication platform in one acute care hospital in order to make recommendations to the larger organization. This evidence-based change of practice project included analyzing productivity/efficiency, quality of care, and communication for inpatient nurses and other members of the interprofessional care team. Since previous implementations were driven by IT, the project also aimed to determine if the creation of a clinically focused implementation guide for nurse leaders would positively impact the go-live of such a communication platform.

### Section III: Methods

#### Context

This health system has a presence in seven of the United States and has 39 hospitals in three of those states. In the hospital setting, clinical communication through technology has changed over the years by adding clinician devices in a haphazard manner, with the result that many clinicians carry up to five devices for clinical communication. Figure 1 illustrates the devices one physician carries on a regular workday in the organization.



*Figure 1:* Devices carried by a physician in a San Francisco hospital, January 6, 2019.

For nurses, there is a mix of devices between the facilities in the health system, with some carrying older analog phones, whose only function is to make calls and receive alerts/alarms, and some carrying newer smart devices. Four years previously, nurses and other clinicians in some of the Southern California facilities had moved to these smart devices with the VCS application in a platform that KP had named integrated healthcare communication (IHC). The capabilities of the IHC platform are listed below (see Appendix H for a full list of the potential capabilities of clinical communication platforms in healthcare today). The hardware

devices include Zebra TC51 mobile computing devices and the Vocera hands-free badge device.

Software capabilities of the platform include:

- Voice calls
- Secure two-way instant messaging
- Access to view and document in the EMR
- Clinical directory with ability to see who is in the hospital at any given time
- Group messaging
- Role-based calling and messaging
- Alert and alarm delivery
- On-call directories

While six of the 39 facilities within the organization had already implemented the IHC platform, no performance improvement data were collected before, during, or after these implementations, and now, the KP-MCX facility was going live with smart devices and the VCS application.

The key stakeholders for this project included leaders and frontline staff at the macro, meso, and microsystem levels of the health system. These stakeholders were highly motivated to see a unified clinical communication platform implemented across the health system. All levels of the facility were aware of and supported improving clinical communication in the organization; although, some levels were more informed than others about the change. As an added incentive, KP-MCX was actively seeking designation by the American Nurses Credentialing Center's (ANCC) Magnet Recognition Program® at the time, and the Magnet nurse leaders were very interested to have a nurse-led project submitted to the KP Institutional Review Board (IRB) process. The project proposal was presented to their shared governance committees, with very positive feedback. The nurse leaders at KP-MCX were encouraged to

nominate two frontline staff nurse co-leads for the project to build their research skills. Two staff nurses were identified to help with the data collection, with help also provided from the nursing director co-lead of the Research Shared Governance Council.

### **Interventions**

The interventions for this project were two-fold:

1. Collect data before and after the facility's IHC go-live to inform the larger organization about the effects of the implementation of a unified clinical communication system at that facility.
2. Create a clinically focused implementation guide to assist future facilities with the implementation of the platform and seek input from nursing leaders regarding the value of the guide.

Before determining the exact details of the interventions, a gap analysis was conducted, a Gantt chart was developed to determine the critical milestones that lay ahead, and a work breakdown structure listed the tasks necessary to conduct the project. An analysis of strengths, weaknesses, opportunities and threats (SWOT) was also performed, detailing the current state of clinical communication in the organization at the time.

### **Gap Analysis**

There were multiple focus areas for analysis of gaps related to this project. These included clinical communication at the larger organizational level, the facility level, the clinician level, and the implementation level (see Appendix I for the full gap analysis).

***Health system level.*** At the organization level, only 15% of the larger organization had the whole clinician team on a smartphone platform with a unified clinical communication process. The other 85% had a mismatched system of smartphones, pagers, analog phones, and

different communication applications, as well as a reliance on older technologies, which places the organization at risk due to poor communication.

**Facility level.** At KP-MCX specifically, hospital leadership were dealing with different communication methodologies in different situations. The lack of standard work processes is a challenge for healthcare leaders who are seeking to “reduce waste, ensure patient safety, improve flow, and achieve balanced and synchronous production of healthcare standards” (Boettcher et al., 2019, p. 153). For KP-MCX leadership, the goal of moving to a standard clinical communication methodology could close the gap by “best utilizing people at their various levels of licensure while keeping the rhythm of hospital operations tied to the flow of patient requirements” (Boettcher et al., 2019, p. 153).

**Clinician level.** Clinicians without a unified platform were using different and often creative, but inefficient, methods to communicate. One nurse in the post-anesthesia care unit (PACU) summarized the gap effectively,

When I need a surgeon, I will start by paging them, then I will try to call them on their work phone. If I cannot find them that way, I will send a text message to their personal phone, then call their personal phone. Then I will call over to the OR. If none of those ways work, I will walk over to the OR to see if they are there (PACU RN, personal communication, January 4, 2019).

These inefficiencies created delays in care, frustration, anger at times, and risk or quality of care concerns.

**Implementation level.** From the implementation perspective, the previous six go-lives were led solely by IT. While the project management principles of initiation, use of tools, scope and expectation delineation, scheduling, technology design, cost control, risk avoidance,

performance reporting, and project closure (Martinelli & Milosevic, 2016) were used appropriately, there was no specific toolkit for the changes from a clinical perspective. A guide or toolkit might include guiding the facility leadership and multi-disciplinary clinical groups in the clinical rationale and evidence in the literature for the change, along with the clinical versus technological steps for implementation of the new processes and technologies.

### **Gantt Chart**

One method to visually demonstrate the schedule, activities, timelines, level of detail, responsibilities, and resources of a project is a Gantt chart (Martinelli & Milosevic, 2016). The Gantt chart for this project included both the activities for the academic milestones for the project lead, broken down by semester, as well as the specific activities around the project. The Gantt chart had two main sets of deliverables: one set required for the course itself and one set for the milestone deliverables for the project. Included in the course deliverables were attendance at the course intensive sessions, delivery on all papers and assignments, completion of a prospectus for the project, writing a manuscript for publication, obtaining a national nursing certification, and authoring and orally presenting the final project. The project milestones include detailed research on the topic of CC&C, a review of the evidence, data collection pre- and post-implementation of the technology in the facility in Southern California, and the creation of an implementation guide for future facilities (see Appendix J for the full Gantt chart for the project work).

### **Work Breakdown Structure**

A work breakdown structure (WBS) details a collection of the elements or tasks that are within the scope of a project. The benefits of developing a WBS include defining what is within and out of scope for a project; helping to keep a project on track, within budget, and on schedule



(Kaufman, 2005); and providing a way to ensure projects have “manageable increments [that are] planned, organized, and controlled” (Martinelli & Milosevic, 2016, p. 126). There was one WBS for the collection of data for the implementation of the technology and one WBS to create an implementation guide that detailed the planning, preparation, and execution of the technology and associated changes in practice expected by the implementation. The project did not include the ongoing support and maintenance of the project after implementation (see Appendix K for a tree structure view of the WBS for this project. To outline the work breakdown structures for this project, the first level of work elements (L1) in both WBS diagrams determined the highest level of work effort and all subsequent work elements stemming from this level.

***Work breakdown structure one.*** The work elements for this project stemmed from the six branches of L1: building the business case, obtaining funding, managing the software and hardware, pre-implementation data collection, post-implementation data collection, and data analysis/recommendations.

***Work breakdown structure two.*** In the second WBS, the work of creating an implementation guide was described. There are six first level work elements (1.1 to 1.6), and the most important first level elements in this WBS are those of gathering information about implementation guides, creating the implementation guide, and then testing the guide with live and non-live sites (1.4, 1.5, and 1.6).

### **SWOT Analysis**

A SWOT analysis is a way to ask, “What are the features or components of the organization and its external context that are key to success ... that allows the organization to consider the risks that will impact these dependencies” (Hopkins, 2018, p. 27). Since the focus of this project was at a facility, the SWOT analysis was focused at the facility level. Strengths of

the project included strong organizational support at the facility to improve clinical communication among the team, and the facility was self-funding the implementation outside of the national project. Another strength was the strong support in the literature for such implementations, and this evidence has been proven over a 15-year period. The opportunities observed were to improve and unify clinical communication, as well as improve quality and safety of patient care. Issues with disparate communication methodologies were seen at the facility, and the opportunity to improve this was supported in the literature. Threats to the project included potential problems with the wireless infrastructure, which risked the stability and functionality of the technology post go-live, if not remediated. Support post go-live was also a threat, with no support staff planned to manage the application and hardware post-implementation. Finally, the project's weaknesses included a lack of a clear clinical implementation framework and a lack of policies and guidelines for the post-implementation timeframe (see Appendix L for the full SWOT analysis).

### **Project Budget**

While the IT return on investment (ROI) is clear, the clinical ROI for this platform is not necessarily in the form of hard-dollar savings, such as the ability to reduce full-time equivalent (FTE) staff count or a hard-dollar decrease in departmental spending. However, the soft-dollar clinical ROI is considerable in the form of quality, safety, and clinician and patient satisfaction. Therefore, a proposal was brought to the health system's executive funding body, which stated that a clinical business partner (CBP) role was needed to work within the IT team. This role was to bring the clinical perspective to the business case and to present the clinical ROI for this unified communication system. Subsequently, \$140,000 of funding was allocated to pay for the project lead's 0.5 FTE wage over a nine-month period in order to correlate the evidence for the

business case. This funding also included travel and expenses. With a facility identified that was going live with this technology, it was decided that part of the CBP's funding could also be used to collect the pre- and post-implementation data. In the five months prior to data collection, the CBP utilized only approximately 35% of the monthly funds allocated, and the project's executive sponsors agreed that the remaining funds could be re-allocated to contract with the organization's non-clinical research team and to engage a registered nurse (RN) project assistant to help with data collection and analysis. Over the nine-month period, the budget had not been fully utilized, and a \$22,000 positive variance was still in place. The facility requested to have two RN co-leads for the project, and the cost of their wages for the data collection period was covered by the facilities nursing department budget. See Appendix M for a month-by-month explanation of the budget.

### **Responsibility/Communication Plan**

The communication plan for this project involved multiple levels at the health system, facility, and clinician levels, as well as with the project lead's academic advisors. See Appendix N for the full communication plan.

*Health system level.* The executive sponsors for the implementation of this unified clinical communication platform were the IT vice president (VP) of Care Delivery Technology Services and the nursing VP of National Patient Care Services at the health system level. They were the senior national-level leaders who approved the data collection project in the facility. As such, all permissions, information, and results were reported to them and the leadership communication project team on a bi-weekly basis. Also, because funds were released to contract with the organization's Research Department, a bi-weekly communication plan was outlined

between the project lead and the research team members to facilitate the planning and execution of the data collection and analysis.

***Facility level.*** The key stakeholders at the facility level were the patient care services (nursing) and the physician and pharmacy leadership teams. These leaders were contacted at the start of the project to request permission to conduct the data analysis at their facility. Since the facility was on the ANCC's Magnet Recognition Program journey, the project team conducted a site visit in the summer of 2019 and attended the monthly shared governance day to explain the aims of the project to seven different leadership councils. The facility's Magnet team asked if there could be RN co-leads from the facility, and calls were arranged with these frontline RNs to strategize about the data collection process and the role of the co-leads. Finally, the nursing director lead of the Research Shared Governance Council and the manager of Clinical Informatics at the facility became the main points of contact for the day-to-day scheduling and logistics of the project, and frequent calls with them were also arranged.

***Clinician level.*** Once the project was approved by the facility leadership team, letters were sent to the department leaders seeking their help in recruiting participants for data collection (see Appendix O). Once the managers identified willing volunteers, they were asked to give a letter to each of the participants (see Appendix P).

### **Cost/Benefit Analysis**

Martinelli and Milosevic (2016) noted that a feasibility assessment is “the heart of a project business case” (p. 70) and includes both the tangible and intangible benefits detailed in quantifiable terms, such as dollars saved or gross margin increase. While the benefits of improved communication have been demonstrated in the literature in terms of quality, efficiency, and staff and patient satisfaction, no formal ROI studies had been done in the already live KP

sites, so an ROI for KP was difficult to determine for this project. Certainly, there was a projected cost avoidance in preventing quality and risk events; however, this was difficult to convert to tangible benefits. Instead, two examples from the literature were included in the national business case. These examples were improved discharge time by over 22 minutes (Siwicki, 2018) and improved operating room efficiency by five minutes per case (Hearon, 2018). These were calculated for one facility in KP in terms of RN staff wage efficiencies, and then multiplied by the 39 hospitals in the system to demonstrate a potential cost avoidance of \$68.6 million dollars over four years (see Appendix Q for the cost avoidance analysis for these two measures).

### **Study of the Interventions**

There are two interventions to study in this project: the pre- and post-IHC implementation data collection and the implementation guide.

#### **Pre- and Post-Implementation Data Collection**

Once KP's national IHC governance team determined that KP-MCX was interested in the study, the organization released funds to obtain assistance from the KP User Experience (UX) Research Department. The UX team were fully briefed on the objectives of the study and the evidence surrounding clinical communication in healthcare and were educated on the conceptual frameworks that determined how end-users accept technology. Technology and clinical communication surveys from the literature were reviewed in detail (Chen, Park, & Putzer, 2010; De Grood et al., 2012; Hoonakker, Carayon, & Cartmill, 2017; Johnson et al., 2015; Joseph et al., 2013; Koivunen, Niemi, & Hupli, 2015; Mehrzad & Barza, 2015; Moore & Jayewardene, 2014; Motulsky et al., 2017; Nagler et al., 2014; Rozario, 2018; Whitlow et al., 2014; Wu et al., 2015), as well as the reports of the communication challenges that KP nurses were already

experiencing. This provided the appropriate background for the project lead and the UX department to design the *de novo* pre- and post-implementation collection tools. The team took these four existing validated and reliable formats: focus groups, one-to-one interviews, direct observations, and online surveys, and utilized them for the data collection at the facility.

The in-person pre- and post-data collection interviews were administered three weeks pre- and five weeks post-implementation and were specific to clinical communication methodologies in the organization at the time of interview, thus ensuring the outcomes were explicitly related to the intervention. To ensure consistency in the data collected, fieldwork guides for the focus groups, interviews, and direct observations were designed by the project lead and provided to all data collectors (see Appendix R for copies of the fieldwork guides and interview questions). The interviews and focus groups were recorded for ease of data collection, and consent to record forms were signed electronically by all participants. Participants included nurses, pharmacists, physicians, and unit assistants in order to obtain a cross-section of the most common users of clinical communication technology in the interdisciplinary team. The facility staff nurse co-leads were instrumental in assisting with the scheduling of rooms, facilitation of schedules, and arrangement of staff to attend the meetings.

***Focus groups.*** Focus groups were chosen as a methodology because they identify themes and “uncover relationships between motives, beliefs, attitudes and behaviors” (Taylor, Kermode & Roberts, 2006, p. 411). They also allow for a more comfortable environment for participants who may feel intimidated by face-to-face interviews (Liamputtong, 2013). Each clinical group had one or more focus group sessions, offered as lunch-and-learn sessions to facilitate attendance.

***One-to-one interviews.*** The same categories of staff were sought to be interviewed one-to-one. In some cases, these one-hour interviews were with the same people as in the focus groups, but in most cases, these were different staff than the focus groups. Departmental directors and managers assisted in facilitating the interviews. According to Polit and Beck (2018), while they are expensive, interviews “yield high quality data” (p. 220), and semi-structured interviews, like the ones performed in KP-MCX, encourage participants to talk freely about many topics. It was found that the one-to-one interviews gave the interviewers the opportunity to ask probing questions, when needed.

***Direct observations.*** To determine how the clinicians were communicating with each other in different situations, the data collection included direct observations before and after the implementation of the new communication system. Polit and Beck (2018) noted that direct observations are beneficial, as they provide an observation of “specific behaviors, actions, and events” (p. 172), as well as provide the opportunity to capture data when people cannot fully describe their behaviors.

***Surveys.*** Finally, short online surveys were used to capture any other information that may have been missed from the focus groups, interviews, and observations. The use of a survey followed Liamputtong’s (2013) recommendation to gather larger amounts of data in small periods of time, to ask more “sophisticated questions, and to file data easily and efficiently” (p. 1999). The survey was distributed to staff on the hospital’s email and intranet, and posters were provided for the facility leaders to post with a quick response (QR) code for ease of scanning directly to the survey.

### **Implementation Guide**

Nurse leaders at the six live facilities had previously provided feedback that they found the go-lives very IT-driven. Previous implementations of this communication technology were focused on the functionality of the technology and the tasks necessary for go-live. Davies, Walker & Grimshaw (2003, as cited in Nilsen, 2015, para. 4) reported that implementation science theories show that “only 10% of studies provide an explicit rationale for their strategies [and] poor theoretical underpinning makes it difficult to understand and explain how and why implementation(s) succeed or fail”. The guide incorporated the process models (translating research into practice), classic theories (explaining what influences implementation outcomes), and evaluation frameworks (evaluating the implementation) that Nilsen (2015) described for highly effective implementations. The intent of the guide was to present the clinical significance of the technology and the organizational workflows that were changing with the implementation and to consider the clinicians’ perceptions of the fit in their organization. The aim was to create a more clinically-focused, step-by-step implementation guide for facility nursing leads that presented rationales, timelines, duties, expectations, and guidance upfront to prepare the lead for what was coming ahead of time (see Appendix S for the implementation guide index of contents).

The approach chosen to assess the usefulness of the guide was to ask nurse leaders throughout the organization to read the newly-created guide and then determine its usefulness by providing direct verbal feedback or by completing an online survey (see Appendix T for implementation guide online survey). The live sites were also asked to give detailed input into areas that might be missing from the guide. The online survey was sent directly with the implementation guide, with a requested two-week turnaround time, again ensuring the feedback



was related specifically to the implementation guide. A plan, do, study, act (PDSA) methodology was utilized to confirm that the observed outcomes of this project were due to the interventions implemented and to ensure the “circular approach to project performance improvement” was confirmed (Martinelli & Milosevic (2016, p. 253). See Appendix U for the project PDSA.

### **Outcome Measures**

Understanding the effectiveness of a clinical communication platform was the desired outcome of this project and the measures chosen to determine this were productivity/efficiency, quality of care, and communication for inpatient nurses as well as other members of the interprofessional care team in a 320 bed acute care hospital in California. The interventions to ascertain if these outcomes were achieved included eight focus groups, 16 shadowing sessions, 31 one-to-one interviews and surveys with 106 responses received. Themes were identified from the results of these interventions and when reviewed under the framework of the outcome measures, these included:

- productivity/efficiency: inability to realize the full potential of a technology that was not fully functioning, nor was it completely understood after training
- quality of care: the agreement that there was a potential to improve the quality of care once the immediate issues were resolved
- communication: the need for a strong Wi-Fi infrastructure to support the new technology in the communication pathways being implemented.

A secondary outcome of this project was the value a clinical implementation guide could bring to future installations of the technology. The learnings from the implementation were transferred as knowledge points into the implementation guide and satisfaction with this was measured through a survey which was sent to six CNEs and 12 informatics nurse and non-nurse

leaders, with overwhelmingly positive responses received from all respondents (two of the CNEs and 11 of the 12 informatics leaders).

### **Pre- and Post-Implementation Interventions**

For the data collection at KP-MCX, the tools described were carefully chosen to gather the maximum amount of data in a short period of time before implementation and then five weeks after implementation. All of the tools utilized were well received by the contributors, but participation was somewhat challenged due to high census during both visits (pre- and post-implementation). While Polit and Beck (2018) state that the cost of having face to face focus groups are an expensive method of data collection, the data yielded from this level of interaction were significant, and was very successful, as it led to gathering rich information about the implementation and reduced barriers in the post implementation data collection period. Being onsite for the three days pre- and four days post-implementation allowed the team to ensure they had the complete and accurate data needed for the pre- and post-implementation comparisons and also allowed the team to pivot when they needed different participants to complete the data collection. By collecting data from the multidisciplinary team, it ensured that different perspectives were observed. Ultimately, this created a collaborative approach where nurses discussed their interactions with providers, pharmacists talked about how they communicated with unit assistants, providers discussed how they interacted with nurses, and unit assistants discussed their collaboration with the whole team.

Written information in the form of letters was provided to all leaders and frontline volunteers from the onsite co-leads before the team arrived on site. The letter stated that anonymity was assured. The focus group and interview sessions were recorded for ease of data collection, and a signed permission to record was obtained from the participants. Since there

were four people performing the data collection, the team ensured interrater reliability by creating written interview tools and by having the four leads meet with the facility co-lead RNs to discuss in detail and agree upon the questions and processes for interviews and observations. The first interviews, observations, and focus groups were conducted in pairs to ensure each member of the interviewing team was consistent in their methodology and interrater reliability was confirmed.

Interview techniques followed Liamputtong's (2013) recommendations for creating a comfortable environment, relaxing the participants, providing the context for the interviews, facilitating the flow of information, providing open-ended questions that allowed participants to respond naturally in their own words, managing both verbose and quiet participants, and closing the sessions on a positive note. By following evidence-based practices for interview techniques, the team felt they had assured both the quality of the data received and the adequacy of the data collected.

The observation techniques utilized included standardizing the approach with the four data collectors, where they observed, asked questions, recorded information, and interacted closely with their participants to gain insights that might have "eluded the team through a more passive approach" (Polit & Beck, 2018, p. 206). During the observations, the team utilized elements of Polit & Beck's (2018) process of noting the physical setting, participants, activities, frequency and duration of the observation, the process, and outcomes of the observations. After all sessions, each data collector sent a personalized thank-you card to the participants to ensure they understood the team's gratitude for their participation. The interview questions, direct observations, and survey questions collected at baseline (pre-implementation) and post-implementation were the same questions but asked with a different emphasis. In the pre-

implementation phase, the questions were asked around the participants' current (pre-implementation) communication hardware and software, while the post-implementation interviews, observations, and surveys clearly delineated that the team was asking about the new technology. Since recordings could not be done during observations, detailed notes from the observation sessions were typed and collated for analysis later.

### **Implementation Guide**

Material for the creation of the implementation guide intervention involved the collection of data from several sources:

- Information was obtained from the literature about technology adoptions, in general, and the elements that can lead to their success. The literature was also a rich source of data from other organizations that had implemented similar technology and had made suggestions for the implementation (De Groot et al., 2012; Hoonakker et al., 2017; Johnson et al., 2015; Koivunen et al., 2015; Machon, Knighten, & Sohal, 2020; Moore & Jayewardene, 2014; Nagler et al., 2014; Wu et al., 2013), as well as evidence-based models and frameworks (Chen et al., 2010; Doyle et al., 2014; Klein & Sorra, 1996; Michel-Verkerke, & Spil, 2013).
- Direct observations of sites within KP that were already live with the technology were conducted. Feedback from frontline nurses and nurse leaders about their implementations, as well as their experiences with using the technology shift-by-shift, was a valuable source of information for the guide. Already live sites reported frustrations in accessing staff due to voice recognition, the cognitive burden from the clinical alarm notification system, and a dislike of the weight of the device. These were all elements that could not be changed in the next implementations, but could be

- recognized, and future facility leads could be prepared for this with the implementation guide.
- Observations from the pre-implementation processes at KP-MCX were also included. These sessions were led by an experienced IT project manager who had previously led the six other implementations within KP. While this IT project manager was certainly experienced in the technology implementation of the platform, it was observed that the clinical workflow elements were not discussed or given as much focus as was possible. After implementation, this was highlighted through some gaps in knowledge from the staff and leadership, and this became a major focus for the implementation guide. Examples of these workflows include knowledge of new emergency code workflows with the new technology, staff knowing the calling process for who was and was not going to be working on the new platform, and processes in the departments for managing downtimes in the new technology.
  - Opportunities observed in the training at KP-MCX were key to the information that was placed in the implementation guide. Training was focused solely on the hardware (the devices) and the software (VCS) and was provided by the vendor. There was no training to the new processes and workflows that were coming with the change in the clinical communication methodologies in the organization, and this led to negative outcomes post go-live.
  - Issues post go-live in KP-MCX were one of the most valuable sources of information for inclusion. The post go-live data collection at KP-MCX clearly demonstrated issues and dissatisfaction with the technology. These data were prioritized for use in the implementation guide, as it provided pitfalls to avoid in future implementations.

- Types of technology used in other organizations were also observed for inclusion. The project lead drew on personal experiences as a clinical and informatics leader to create the structure of the implementation guide. Bringing experiences from other organizations helped to show multiple perspectives to KP and inform the guide.
- Unexpected feedback from the live sites after the KP-MCX implementation proved useful for the guide within a COVID context. No more sites were planned to go-live with the platform after KP-MCX's implementation; however, with the COVID pandemic, Vocera badges were distributed (without the complete platform) for isolation room communication. Interviews with nurse leaders from these facilities provided useful information to include in the guide, especially for COVID workflows.
- Finally, once a draft of the guide was finished, feedback was sought from nursing and informatics leaders in the live and soon-to-be-live sites, as well as from the IT project manager and leadership on the project. This information was then added to the guide.

All the data points above provided the information necessary to assure the information accurately represented a guide that could be assessed by key stakeholders for its usefulness.

### **Analysis**

No software was utilized in the analysis of the implementation as the data were manually analyzed by the project lead, as well as by the organization's research department staff . Since there were two interventions in this project, the analysis is described in two sections below: one for the pre- and post-data collection and one for the implementation guide.

#### **Pre- and Post-Implementation Data**

As described, data collection for this project utilized mixed methods that included interviews, focus groups, direct observations, and online surveys; therefore, both quantitative and qualitative methods were used for data analysis.

**Interviews.** During the interviews, staff were asked to rate pre-set statements on a scale of 1 to 10. An example statement was, “The communication tool I am provided supports effective and efficient care delivery.” Because of the numerical rating of these questions, a quantitative assessment was able to be determined for these questions. However, the interviews also yielded rich qualitative statements from the participants, and the data were analyzed and coded, and a thematic analysis was created. This analysis followed Miles and Huberman’s (1994) framework (as cited in Moule & Goodman, 2014) of coding data, so it can be reduced, displayed, and conclusions can be drawn and verified.

**Focus groups.** No Likert-type questions were given in the focus groups, so no quantitative data were obtained. The qualitative data were analyzed, coded, and placed into themes using the same process as mentioned previously.

**Direct observations.** The shadowing portion of the data collection helped to validate the data collected during the interviews and focus groups and gave further insight into the unique needs and challenges faced on a day-to-day basis by the participating clinicians. Qualitative thematic analysis was conducted on the comments and observations during these shadowing periods, and at the suggestion of the frontline staff, day and evening shifts were observed in nine different departments, yielding different data for the different shifts.

**Survey.** An online, anonymous survey was designed to elicit both quantitative and qualitative data. Quantitative methods were utilized to measure the online survey and collection

of metric data pre- and post-implementation, which included determining if certain metrics improved with the implementation.

### **Implementation Guide**

The second part of the project was to create a toolkit or guide for future implementations. As mentioned, leadership at the six facilities that are already live on this platform had stated that they found the go-lives very IT-driven. The PICOT question for the second part of this project asked, for inpatient nurse leaders, would a preparation and implementation guide (compared to no guide) positively impact the implementation of a smartphone communication platform in their hospitals? Klein and Sorra's (1996) implementation model states that how well an innovation is adopted is a result of the organization's climate and the organization's employees' perceptions of the fit of the innovation within the organization's values. Previous implementations of this communication technology were focused largely on the functionality of the technology and the tasks necessary for go-live. The guide's aim was to add elements to the technical guide that included introducing the rationale and clinical ROI of the technology, discussing organizational culture, and considering the clinicians' perceptions of the fit in their organization. The guide was written using information from other KP live sites in Southern California, as well as detailed information learned from the KP-MCX go-live. The guide sections include background to the project, descriptions of the technology, and detailed step-by-step instructions for implementation leads on the different stages of the project they will be leading, including sample presentations to executive leadership, timelines, details of the workgroup duties, expected workflow changes, and recommendations on training, go-live, and post go-live support.

The first draft of the guide was prepared and sent to members of the IT team for their input and suggestions regarding the technical elements of the guide. After completing the second



draft, it was sent to the directors of Clinical Informatics in the Southern California and Northwest KP regions. They have been overseeing the implementations in the six sites in Southern California and two in Oregon, and they provided valuable input on structure, content and addition information utilizing their subject matter expertise in the area of nursing leadership and informatics.

To analyze its effectiveness, the guide was sent to nurse leaders and clinical informaticists in the six live Southern California sites to determine if it covered all elements from their go-live, to see if they perceived the guide would have been useful in their go-lives, and to ask if there were any items missing. It was also sent to key nurse leaders and clinical informaticists in the non-live sites to determine if they felt the content of the guide would be useful to them, if they had any input into the guide, and if there were unanswered questions they may have after reading the guide. The guide was accompanied by a six-question survey tool with quantitative and qualitative answers (see Appendix T for survey questions).

When asking the nursing and informatics leaders for input into the guide, one variation to be accounted for was the different processes in the different regions (Northern California, Southern California, and the Northwest regions of KP). Within these different regions are different philosophies, cultures, nomenclatures, union environments, and rollout methodologies. Each time feedback was received, a new iteration of the guide was completed, until it had all the feedback incorporated. The guide was also streamlined along the way to ensure it was truly a usable document for the facility leads in the future.

### **Ethical Considerations**

The focus of this project was to determine if a clinical communication platform can improve staff efficiency and the quality of care provided. To do this, staff were interviewed and assessed; therefore, potentially making staff human subjects from a research perspective. As such, there was an ethical responsibility to ensure these participants were protected from harm and discomfort, they were not exploited in any way, they had the right to be treated fairly with dignity and privacy, and they had full disclosure of all events that may occur during the project (Polit & Beck, 2018). With that in mind, an application was placed with the health system's IRB to determine if this project fell under the umbrella of human subject research. The IRB determined this was not human subject research and designated the work as a performance improvement project (see Appendix V). Permission was also granted from the project lead's health systemwide direct nurse leader for the project to be conducted (see Appendix W).

On October 14, 2019, the University of San Francisco's (USF) DNP department determined that this project met the guidelines for an evidence-based change of practice project, as outlined in the DNP project checklist (statement of determination) and was approved as non-research (see Appendix X for the USF Non-Research Determination Form). There were no identifiable issues or conflicts of interest noted for this project. Finally, in creating this project, the USF Jesuit values were taken into consideration, as the USF's value statements describe their respect "for every individual's intellectual, physical, and spiritual health and autonomy" (USF, 2019, para. 2).

Even though the project did not fall under the purview of the IRB, there was still a responsibility on the part of the project lead to ensure all staff felt safe and protected as they were interviewed and observed in their place of work. All staff who participated in any of the activities for this project were given written permission forms and were told that all information reported from the project would be anonymized. They were assured that no names were associated with their information, information directly attributed to them would not be reported to their managers, and their participation was voluntary. This aligns directly with the Provision 3.2 of the American Nurses Association's (2014) Code of Ethics, which confirms that all research must be approved by the institution's IRB and that individuals have the right to choose whether to participate in the research or not participate.

## **Section IV: Results**

The project was conducted in two parts; therefore, the results will be presented in two separate sections. Additional unexpected results due to COVID-19 are also included.

### **Pre- and Post-Intervention Data Collection**

For this study, the formal pre-go-live studies were done two weeks before go-live and five weeks post go-live. For the question, “Does the introduction of smartphone communication strategies (compared to no smartphones) have a positive effect on productivity/efficiency, quality of care, and communication in a large hospital system within a six-month period post go-live?” the immediate results did not support the evidence-based question. There is evidence in the months following (during COVID-19) that productivity, quality of care, and communication did improve with the implementation of parts of the technology.

As a high-level overview, the qualitative data collected in the immediate period post-implementation for KP-MCX demonstrated negative results, in general, with only a small number of positive themes noted. Overall, the results established that staff found secure messaging very useful and that the battery life of the devices improved from pre-implementation. However, the reliability of the device was severely compromised by poor Wi-Fi connectivity, and the overall feedback from staff post-implementation was that the technology did not meet end-user needs. While an extensive Wi-Fi assessment had been conducted prior to go-live, changes made by an IT team unaware of the IHC project caused reliability issues for the clinical users after go-live. Because of that, in many cases, they were still carrying their old analog phones and were challenged with integrating the new devices into their workflows. Apart from the reliability issues, feedback from staff included that the devices were clunky, heavy, the clip was not sturdy, and the interface was not easy to use, including the keyboard, size of the screen,

and findability of features on the device. From a training perspective, staff reported that the new communication workflows were not well understood, and nurse leaders stated that the transition plan and operations strategy was not available for their review. Finally, the platform did not align with user expectations or the mental model of what a communication device should be, for example, one staff member said, “It’s a phone, but you can’t dial a number.”

**Interviews.** Seventeen one-to-one interviews were conducted pre-implementation and 14 were done post-implementation. RNs made up the majority of participants pre-implementation, with ward clerks, physicians, and pharmacists making up the remaining participants. Post-implementation, RNs were again the largest group, and the remaining participants were physicians, child life specialists, ward clerks, operators, and pharmacists. The interviews were both quantitative and qualitative in nature, and the participants were asked the same set of questions on a scale of 1 to 10 pre- and post-implementation. Quantitatively, the interview results demonstrated two of the eight questions showed an improvement (better maintenance and reliability) post-implementation, but eight questions showed a reduction in satisfaction with clinical communication at their facility. Table 1 displays the results, with the intended scores to denote < 7.0 being a detractor, 7.0 to 9.0 being neutral, and > 9.0 a promoter.

Table 1

*Pre and Post Interview Question Results*

Statement	Pre-Implementation	Post-Implementation
The communication tools I am provided are maintenance free.	6.8	7.5
The communication tools I am provided are reliable.	6.7	7.0
The communication tools I am provided support effective and efficient care delivery.	7.2	6.6
The communication tools I am provided support patient or family member satisfaction.	7.9	6.3
The communication tools I am provided support patient safety.	7.9	7.5
The communication tools I am provided support quality communications.	7.7	7.5
The communication tools I am provided result in efficient turnaround times.	7.6	6.9
The communication tools I am provided support care team engagement.	8.4	7.5

Qualitative results from the interviews were also mixed. Staff were given either a TC51 smart device or a Vocera hands-free badge, depending on their unit, and reported some successes, but mostly frustration with the new technology (see Appendix Y for a full synopsis of the pre- and post-implementation data collection).

**Focus groups.** The goal of the five pre and post focus groups were to facilitate the gathering of information, with the added advantage of the group bouncing ideas off each other. The data collected in the focus groups mirrored the sentiments of the one-to-one interviews which indicated a level of dissatisfaction with the technology, yet because of the focus group format, the potential of the technology was highlighted by staff once the connection issues were resolved. Difficulties using the badge *genie* (the central number) and the form factor of the device (size, weight, multiple steps to make a call) were also themes noted in the focus groups. (see Appendix Y).

**Direct observations/shadowing.** The data collection pre- and post-implementation included time spent with each group while they did their work in their departments. While this was a limited amount of time, the 12 observations before implementation and 11 after implementation were useful in that they validated the data collected during the interviews and focus groups, as well as learning other key insights into the unique needs and challenges of each team and their communication methodologies. The difficulties noted in the interviews and focus groups were seen first had during the post-implementation shadowing, yet successful use of the technology was observed, and positive comments were elicited from clinicians on the units.

**Online survey.** The goal of the survey was to gain high-level, quantifiable insights into the pulse of the organization in an anonymous manner without the researchers present. Twenty-six surveys were completed pre-implementation and 80 surveys were completed post-implementation. Flyers were posted with details of the survey and since it was open to all staff before and after the go-live, it is unknown what percentage of the same staff completed both the pre and post survey. Staff were asked to rate if they agreed or disagreed with statements in the survey, and all results at the *agree* or *strongly agree* level were correlated. Across the board on each question, the scores were lower post-implementation (see Table 2)

Table 2

*Pre and Post Online Survey Question Results*

Statement	% Pre-Implementation (n=26)	% Post-Implementation (n=80)
I am confident the tools provided to me support the clinical communications I need for care delivery.	88	45
I find the tools provided to me support high-quality clinical communications.	62	43
I find the tools provided to me for clinical communications are easy to use.	81	33
I am confident the tools provided to me for clinical communications are reliable.	50	28
I received adequate training on the tools I use for clinical communications.	58	51
The tools I am provided for clinical communications make it possible for me to successfully complete all necessary communications tasks for care delivery.	81	28
The tools I am provided for clinical communications support care team engagement.	62	30
The tools I am provided for clinical communications support fast turnaround times.	62	26
I felt very confident using the tools I am provided for clinical communications.	85	33
I needed to learn a lot of things before I could get going with the tools for clinical communications I use today.	46	49
The tools I am provided today for clinical communications require little to no maintenance.	54	35
The tools I am provided today for clinical communications support high patient/caregiver satisfaction.	42	31
The tools I am provided today for clinical communications support patient safety.	42	16

The survey also included the opportunity for staff to add comments to open-ended questions, again with some positives, but most displaying negative findings (see Appendix Y).

### **Results from Other Hospitals within the System Due to COVID-19**

While not a formal part of the data collection, this project evolved alongside the evolution of the COVID-19 pandemic in the United States in March 2020. Many hospitals within the health system sought technological solutions to the communication difficulties that the



pandemic brought about. In interviews with nurse leaders who had quickly implemented and utilized the IHC technology in Southern California because of pandemic workflows, the results were overwhelmingly positive. Managers reported the secure messaging functionality was popular, as the charge nurse was outside the isolation units and the staff inside could text to communicate with them. Device earpieces worked well when staff had donned their Powered Air Purifying Respirator (PAPRs); although, some staff did not like the feeling of the bulky earpiece. While no formal study was done around the reasons for the success of the technology in this time was done, it could be supposed that in the pandemic situation, where severe pressure was placed on existing processes and workflows, any solution that could ease the communication burden was warmly welcomed. One manager stated, “Vocera has been extremely useful during COVID-19: a 10 on a scale of 1-10,” and another stated, “The command center used it all the time to send group broadcasts during the height of COVID.” Finally, the ‘role’ and ‘group’ messaging functions were particularly useful with roles/groups set up for each of the new communication workflows needed for the pandemic. These included roles/groups for staff who were assisting clinicians into and out of their personal protective equipment (med-surg/ICU donner and med-surg/ICU doffer) as well as roles set up for a family update nurse and groups for the OR intubation team, the COVID labor pool, COVID-19 questions, and command center call tree groups.

### **Implementation Guide Intervention**

Feedback from the implementation guide was intended to be collected both quantitatively through an online survey, and qualitatively through comments inserted directly into the guide or given verbally. Before feedback was sought from end-users, the two informatics leaders from other KP regions, as well as the members of the IT project team who had previously been leading the implementation reviewed and gave input into the guide, and five inputs were received. Four

chief nurse executives (CNEs), four senior IT leaders, and 14 nursing informatics managers or directors were then asked for their input. Participants had either implemented the platform already or were going to be implementing it soon. Input was slow to be received, even with reminders and prompting. The online quantitative survey was only completed by one respondent and was therefore abandoned. Participants preferred to write their feedback directly into an email or onto the guide or called personally to give verbatim comments. These comments were then collected, analyzed, and added to the guide in the appropriate sections.

IT leadership who gave feedback ensured that all elements of the technologies were represented appropriately in the guide. They felt the comparison of old and new technologies included in the guide was not necessary; yet, the feedback from the CNEs was that this comparison was very helpful, “It tells the story nicely about features a nurse leader can tell their staff that they now have access to”, therefore it was left in the document. The only CNE who gave feedback into the document requested that a draft timeline be included to spell out “when should I start work on this project.” While a high-level timeline had been in the original document, a more detailed one was added that focused on the role of the facility lead. She also stated she was confused between the core group and workgroups, so this was clarified in the guide. One key element she asked to be included was to ensure that the facility lead was the actual leader of the sessions where the new workflows were determined. As overall feedback, she stated, “It’s long, but for a nurse leader who is a novice in these clinical communication technologies, this is an extremely informative guide.” Finally, she asked if there was a pocket guide that will detail a summary of the different hardware and software, and it was explained that the vendor provides this type of pocket guide.

The remaining feedback was received from informatics managers or directors in the region that will be implementing the technology in the near future. Specific recommendations that had a positive impact on the guide included:

- Adding details of when and how the old technology will be removed from use, who is responsible for this collection, and how the old technology will be disposed of in an environmentally friendly manner.
- Since the nursing element is rolling out first, ensuring there is a solid support structure post-implementation that prevents the 24/7 responsibility falling to nursing at the facility, especially when non-nursing departments are going live later.
- Providing the criteria for determining which departments will get which technology (smart device vs hands free badge).
- Detailing specific downtime procedures for the technology as well as adding a troubleshooting section for post go-live.
- Making the ongoing governance section more robust, including the process locally and regionally for larger issues like alarm management on the device. This includes governance of new technologies that might be requested in the future to ensure they are compatible with the IECCS devices.
- Placing a higher emphasis on the involvement of IT support, telephony and the telecommunications systems in the preparation for go-live.
- Adding videos that demonstrated the technology for those more visual learners and highlighting more the need for training of departments without the technology (i.e. how they will communicate with the live departments).

- Providing templated policies and procedures to the guide (these will be developed for the regions and will be added for all future go-lives after the upcoming regional pilot for 22 hospitals).
- Increasing the details around key benefits and purpose of the guide in the executive summary.

As each piece of feedback was received, the guide was updated, and continued feedback was sought with each iteration. Verbatim comments from the reviewers of the guide were all positive, with two leaders stating it was “impressive work” and others stating it “looked amazing”, was “very organized”, was “wonderful” and “I love it”. No negative feedback was received and the constructive additions above were added as they were received.

## Section V: Discussion

### Summary

The aim of this project was to see if a clinical communication technology implementation improved productivity/efficiency, quality of care, and communication in a large hospital system and if an implementation guide would help with future implementations. With six out of eight post-implementation interview questions demonstrating a reduction in satisfaction and 13 out of 13 post online survey questions also demonstrating a reduction in satisfaction, the results clearly demonstrated that staff did not feel the technology improved care in their departments. Yet, the implementation provided valuable insights about the pitfalls of such go-lives, and these learnings are clinically significant in that they were utilized to avoid similar issues in future implementations. These learnings also provided valuable data for the preparation of an implementation guide, which nurse leaders clearly believe will have a positive impact on the implementation of a smartphone communication platform in their hospitals in the future.

A key finding of this project was that a clinical communication platform is only as good as the wireless system on which it operates. If that wireless system is not operating successfully, the communication platform will be seen as not functioning and, therefore, will not be useful to staff. However, with the evolution of the needs of the organization during the COVID pandemic, the technology was also implemented in other hospitals within the system. In those hospitals, the findings were impressive, so much so that it could be said that the objective of the project *was* reached in those organizations. Also, the *failure* of the first intervention contributed most importantly to the success of the second intervention, which was the implementation guide. It is projected that the learnings from the KP-MCX implementation will provide the valuable insight needed for the success of 22 further implementations in the organization in the near future. The

dissemination of the implementation guide will be done approximately three months before each of these facilities go live, which will give the facility leads time to absorb the information and operationalize the plan. Based on the feedback from reviewers of the implementation guide, it is expected that this will improve future go-lives in the organization.

The implications for advanced nursing practice of the project is that there is now a valid and clinically-focused guide that can help nurse leaders implement a communication system efficiently, “providing the right information to support problem-solving and decision-making and helping to establish and maintain alignment among business strategy, project strategy, and project execution outcomes” (Martinelli & Milosevic, 2016, p. 3). The guide utilizes the concepts from Michel-Verkerke and Spil’s (2013) USE IT-adoption-model, which states there are four determinants to the success of the adoption of IS systems: relevance, requirements, resources, and resistance.

### **Interpretation**

The evidence in the literature outside of KP clearly demonstrates the benefits of implementing technological solutions for clinical communication (Agarwal et al., 2010; Bautista et al., 2018; Breslin et al., 2004; Brooks, 2018; Brown-Manhertz, 2017; Chatterjee et al., 2009; Devrim et al., 2019; De Grood et al., 2013; Jeon & Park, 2015; Machon et al., 2020, Martin et al., 2019; Mehrzad & Barza, 2015; Menon & Rivett, 2019; Mickan et al., 2014; Motulsky et al., 2017; Patel et al., 2016; Runyon, 2018; VanDusen, 2017; Vermeir et al., 2015; Whitlow et al., 2014). The benefits of improving communication are obvious; yet, if the implementation process has significant issues, the benefit is not realized, as in the case of KP-MCX. This occurred due to a number of reasons, including poor connectivity, which the end-users correlated to “Vocera not working”; a lack of training for and understanding of the new communication expectations and

methodologies; a technology-focused than clinically-focused implementation; and a lack of understanding regarding the paradigm shift that was about to occur in the whole organization.

While there was no statistically significant improvement in communication after the implementation, there was a clinical significance to the implementation in KP-MCX. Lefort (as cited in Ranganathan, Pramesh, & Buyse, 2015) stated that clinical significance “should reflect the extent of change, whether the change makes a real difference to subject lives, how long the effects last, consumer acceptability, cost-effectiveness, and ease of implementation” (p. 169). This is particularly pertinent in this study. The clinical significance of the findings at KP-MCX are the learnings that can be taken from this implementation and applied to future installations of this technology. The impact at KP-MCX to the staff was significant, with negative feelings and distrust of the new technology. Yet, the impact to the organizational system was positive, as the learnings from KP-MCX can now be taken to prevent the same issues in the next facilities.

Post-implementation, there were significant IT costs to the remediation at KP-MCX, as well as the cultural and emotional cost of a *failed* implementation, especially in departments that had to revert to their previous analog communication methods. This type of failure is devastating to a project, and there will be a substantial benefit to avoiding and managing these potential risks in the next implementations. By identifying the risks and providing mitigation strategies for these issues in the implementation guide, the organization can then pre-empt problems before they occur and manage them proactively as recommended by Martinelli & Milosevic (2016, p. 377).

Because the wealth of knowledge in the field exists from previously successful implementations, it was assumed that this implementation would improve productivity/efficiency, quality of care, and communication. While this was not realized in KP-MCX, it was realized in other KP organizations, and enough data were captured to ensure success as the

technology is spread in future implementations. The goal of the implementation guide is that it will provide the tools necessary to spread this technology in a positive manner and sustain the improvements that other KP sites have noted with its implementation.

Challenges that were noted at KP-MCX, including the statement, “We don’t know how to contact physicians, some want calls, some don’t, a process for escalation is not defined,” should be mitigated in the future if facility leads follow the steps in the guide, and examples like this should be thought about in advance in order to help education departments focus their efforts in staff training for the new technology. The training gaps identified in the KP-MCX implementation provide a rich source of detailed information for the next facilities to include in their curriculum. Learning from these gaps should help trainers include role- and workflow-based training scenarios that will help adult learners grasp the concepts of the new technological workflows. These include not only the technology and how it works, but also expectations (i.e., it is not a “phone,” dialing a number is not the same as before) and workflows associated with the new technology. Finally, the next facilities to implement the technology need to have strong governance processes in place in case there are major issues, like those that occurred at KP-MCX when connectivity was poor in the immediate days post go-live.

### **Limitations**

The intention of having multiple methodologies for assessing the implementation was to prevent bias associated with only one data collection methodology. As evidence in the literature had shown the efficacy of this technology in other organizations, the project lead admits there was a certain amount of bias with the expectation that this was going to be successful. This was mitigated by frank and open conversation with the other project members and a realization that this could occur. Every effort was made to host interviews and focus groups with no bias



demonstrated to staff at the facility. Another potential limitation was that there was no guarantee that same people were interviewed/surveyed pre- and post-implementation, and this means a true comparison of the same individual's feelings about the technology could not be conducted. This was due to the limited availability of staff in both phases and the random allocation of the survey tool via posters encouraging completion or the anonymous survey. On review, the addition of a simple survey question: "did you complete a pre-implementation survey" would have mitigated this lack of visibility into the issue.

The major limitation of the project was the skewing of the data due to the poor Wi-Fi capabilities in the facility post go-live. Connectivity issues directly affected the technology performance, with staff relating the poor performance to the technology and not the Wi-Fi. There is no way to effectively determine if the new technology was actually meeting their needs, because the technology did not work effectively due to connectivity issues. While a technology assessment had been done in the week prior to deployment, two different IT departments were working on different projects and changes made by one department was the ultimate cause of the poor connectivity for the other department post go-live. This will now be mitigated by instituting an *IT change freeze* in the week(s) before go-live in future implementations.

These limitations could be reassessed by conducting another staff survey; however, in subsequent interviews with nurse leaders at KP-MCX, while the Wi-Fi connectivity issues have improved, staffs' relationship with the new technology continues to be tenuous, and a return visit for further data collection was not advised by nursing leadership.

## **Conclusions**

This project has demonstrated that care teams are complex organisms, and care team communications require easy, quick, and efficient access to others. The barriers faced in this

implementation caused multiple issues and ultimate dissatisfaction with the technology that was supposed to assist the staff. One staff member summed up the implementation quite effectively;

“I think it has the potential to be more efficient and more effective in making patient care happen or addressing issues more quickly. I think it’s just everyone needs to be on the same page about being good about tech, like assigning yourself to a room or a role, to be checking your messages and responding to them” (KP-MCX Pharmacist, personal communication, November 5, 2019)

An implementation guide that facilitates consistent processes will be instrumental in the success of future go-lives. Organizations need to ensure rigorous testing of Wi-Fi systems before go-live, strong preparation of facility leads, and detailed training of staff that focuses on the technology *plus* the workflows and new communication systems. Engaging potential end-users in understanding the facility’s current workflows, technologies, and the unique needs of different departments will be vital to the success of future go-lives. A solid process in the form of a grid for end-users, in which the methodologies used to contact people post-implementation are clearly detailed, is vital. This should include how to contact various user types, how to handle escalations, and how to get questions answered quickly. Leadership needs to send out regular messages in the weeks before go-live with details concerning what is changing and what is coming next. Roadshows, FAQs (frequently asked questions), and ongoing communications will provide effective ways to demonstrate the different journeys that end-users will be taking post-implementation and the key benefits of the new technology. Standardized policies, procedures, and processes (including log in/roll assignment, communication etiquette, and shift-to-shift handoff expectations) should be in place before go-live for all staff to follow, and this should be included in the contextual role-based training that is provided for all staff. Strong on-unit support

staff or out-of-the-count super-users available during and after go-live will help bridge any gaps missed in training, and a strong governance process pre and post go-live will help by providing a robust process to escalate immediate concerns where “showstopper conditions” might require top manager intervention (Martinelli and Milosevic, 2016, p. 331) as well as bring the nursing voice to the leadership table to guide the organization in the implementation (Machon, Knighten, & Sohal, 2020)

While this implementation did *not* meet the first PICOT question at KP-MCX, it was still successful in other facilities for their COVID workflows. It can also be considered successful as it informed the content for the second intervention, the implementation guide, which will prevent the same occurrences happening in future implementations.

## **Section VI: Other Information**

### **Funding**

This project was instituted to bring the clinical perspective to the IHC business case and to present the clinical ROI for a unified communication system at KP. Subsequently, \$140,000 of funding was allocated to pay for the project lead's CBP 0.5 FTE wage over a nine-month period in order to correlate the evidence for the business case, including travel and expenses. With KP-MCX identified as going live with this technology, it was decided that the CBP's 0.5 FTE funding could also be utilized to collect the pre- and post-implementation data. In the five months prior to the data collection, the CBP had utilized only approximately 35% of the monthly funds allocated, and the project's executive sponsors agreed that the remaining funds could be re-allocated to contract with the organization's non-clinical research team and to engage an RN project assistant to help with data collection and analysis. Over a nine-month period, the budget had not been fully utilized, and a \$22,000 positive variance is still in place.

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## Appendices

### Facility Departments

	Unit Name	# of Beds/ Bays/Rooms	Population	Unit Type	Specialty
<b>Acute and Critical Care</b>	DOU	22	Adult – Inpatient (IP)	Step Down-Adult	Med-Surg Step- down
	ICU	30	Adult – IP	Critical Care-Adult	Medical ICU
	Med/Surg - 4 West	32	Adult – IP	Med-Surg Adult	
	Med/Surg - 5 West	32	Adult – IP	Med-Surg Adult	
	Med/Surg/Tele - 5 East	32	Adult – IP	Med-Surg Adult	Cardiac Med- Surg
	Tele - 6 East	32	Adult – IP	Medical Adult	Cardiac Med
	Tele - 6 West	32	Adult – IP	Medical Adult	Cardiac Med
<b>Maternal and Child Health</b>	Neonatal ICU	49	Neonatal – Inpatient	Critical Care-Neonate Level III	
	Family Centered Care	48	Obstetric – Inpatient	Antepartum/Postpartum	
	Labor and Delivery	18	Obstetric – Inpatient	LDRP	
	Pediatric ICU	8	Pediatric – Inpatient	Critical Care-Pediatric	
	Pediatrics	17	Pediatric – Inpatient	Med-Surg Pediatric	
<b>Peri- operative Services</b>	KP-MCX OR	14	Perioperative Services Hosp	OR-Reduced staff after hours	Hospital
	KP-MCX PACU	64	Perioperative Services Hosp	Pre/Postoperative includes Phase I	Hospital
	BLF OR	Not in Scope	Perioperative Services	OR-No afterhours services	Free-standing
	BLF PACU	Not in Scope	Perioperative Services -	Pre/Postoperative includes Phase I	Free-standing



	Unit Name	# of Beds/ Bays/Rooms	Population	Unit Type	Specialty
<b>ED</b>	Emergency Department	79	Emergency Services	ED-Greater than 80,000 Annual Visits	Adult/Pediatric ED
<b>Other Departments</b>	Home Health	Not Applicable	Workgroup	Hospice/Palliative Care	
	Hospice	Not Applicable	Workgroup	Hospice/Palliative Care	
	Pediatric Care	Not Applicable	Workgroup	Transport/Flight RNs	
	Specialty Nurses	Not Applicable	Workgroup	Vascular Access RNs	
	Utilization Management	Not Applicable	Workgroup	Case Management	
	Hemodialysis	Not Applicable	Ambulatory Care Based at Hospital	Procedural Unit	Dialysis

Appendix B

Go-Live Departments and Their Devices

	A	D	L	M	N	O	P	Q	R
1	Unit/Department	KPHC Rover?	User List Count	DID	TC51 Nee	TC51 Spar	Badge Nee	Badge Spar	Comments/notes
2	SPD	No	39		5	0	1	1	
3	Diagnostic Imaging	No	174		12	0	15	1	
4	ED	Yes	300		55	2	0	0	
5	NICU	Yes	128		10	1	25	1	
6	OR	No	88		46	1	6	1	6 badges for OR Transport
7	PACU	Yes	74		48	1	0	0	
8	4 East Peds	Yes	40		9	1	0	0	
9	PICU	Yes	30		8	1	0	0	
10	4 West Med-Surg	Yes	69		20	1	0	0	
11	5 West Med-Surg	Yes	68		18	1	0	0	
12	5 East Med-Surg/Tele	Yes	68		21	1	0	0	
13	Hemodialysis	Yes	14		6	0	0	0	
14	KP HealthConnect	TBD	13		3	0	0	0	CIS and LTS team
15	Clinical Technology	TBD	8		4	0	4	0	
16	Infection Prevention	No	4		3	0	0	0	
17	Respiratory Therapy	Yes	78		0	1	0	0	Went live with Rover/TC51's - got 17 from Rover, asked for 3 more and chargers
18	Supply Chain	No	41		3	0	14	1	Dept may have or get iOS device for Epic Inv Mgmt (separate project/effort from Buy2Pay)
19	Medical Social Work	No	28	Yes	24	1	0	0	
20	House Sups	TBD	6		2	0	0	0	
21	Wound/PIIC/Stroke Nurse	TBD	7		4	0	0	0	2 piic/2 wound/1 stroke (has iphone)
22	Inpatient Pharmacy	No	58		12	0	0	0	
23	Rehab Services	No	20		17	0	0	0	
24	IQM	No	45	Yes	21	0	0	0	
25	Food & Nutrition	No	67		6	0	14	1	Per Jana - 14 Badges for kitchen, 6 TC51's for Dieticians
26	All Ward Clerks	N/A	24		0	0	0	0	For User List collection only
27	All Monitor Techs	N/A	28		0	0	0	0	For User List collection only
28	DOU	Yes	65		14	1	0	0	
29	ICU	Yes	70		18	1	0	0	
30	ICU Pod3	Yes	3		7	0	0	0	
31	Lab	No	57		10	0	12	1	10 TC51's for managers, 12 badges for staff
32	6 West Telemetry	Yes	84		17	1	0	0	
33	6 East Telemetry	Yes	86		17	1	0	0	
34	Transport	Yes (iOS device)	33		0	0	0	0	Will be getting iOS wifi device from Rover. 15 devices from Rover.
35	FCC/Post Partum	Yes	80		20	1	0	0	
36	L&D	Yes	94		17	1	0	0	
37	EVS	Yes (iOS device)	252		0	0	6	1	Will be getting iOS wifi device from Rover. Have pagers as well 45 devices from Rover.
38	Hospital Medicine	Haiku	44		0	0	0	0	Docs have iPhone, depends on Code/Alarms. Other Physician groups?
39	BioEthics	No	1		0	0	0	0	iPhone
40	Ombudsman	No	1		0	0	0	0	iPhone
41	Spiritual Care	No	1		0	0	0	0	iPhone
42	Admitting	No	45	Yes	10	0	0	0	
43	Device spare/flex pool	N/A	N/A		0	25	0	10	
44			2435		487	43	97	18	
45					530		115		TOTALS

**Appendix C**  
**Current and Future Devices**

Current:



Cisco 7925



Zebra TC51

Future:



Vocera Badge

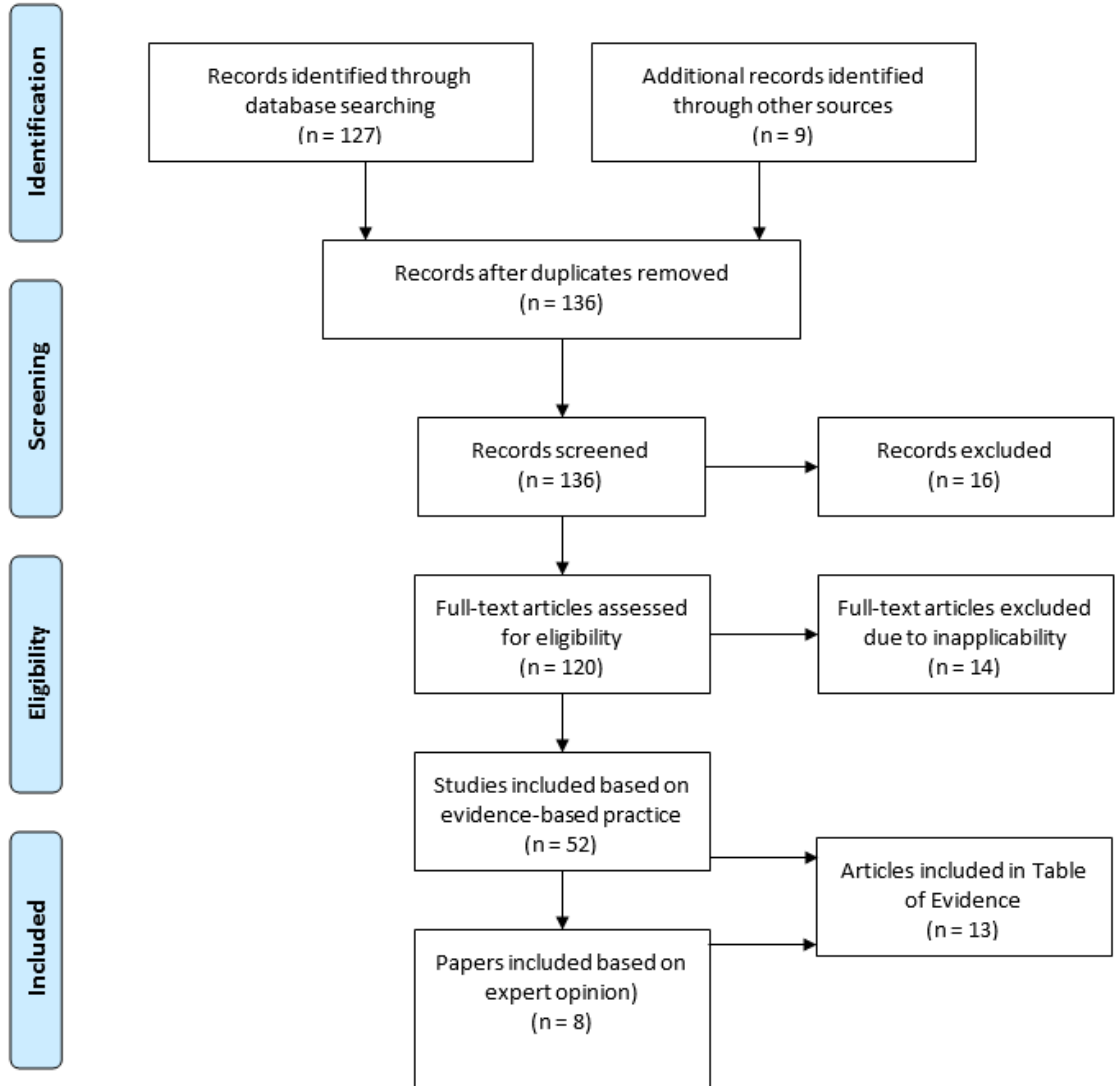
Appendix D

PRISMA Flow Diagram



PRISMA 2009 Flow Diagram

Michelle Machon, 2019 Review of Literature



Appendix E

Johns Hopkins Research Evidence Appraisal Tool

Johns Hopkins Nursing Evidence-Based Practice  
Appendix E: Research Evidence Appraisal Tool

Evidence level and quality rating:		_____
Article title:		Number:
Author(s):		Publication date:
Journal:		
Setting:	Sample (composition and size):	
Does this evidence address my EBP question?	<input type="checkbox"/> Yes	<input type="checkbox"/> No Do not proceed with appraisal of this evidence.

**Is this study:**

- **Quantitative** (collection, analysis, and reporting of numerical data)  
 Measurable data (how many; how much; or how often) used to formulate facts, uncover patterns in research, and generalize results from a larger sample population; provides observed effects of a program, problem, or condition, measured precisely, rather than through researcher interpretation of data. Common methods are surveys, face-to-face structured interviews, observations, and reviews of records or documents. Statistical tests are used in data analysis.  
 Go to Section I: Quantitative
- **Qualitative** (collection, analysis, and reporting of narrative data)  
 Rich narrative documents are used for uncovering themes; describes a problem or condition from the point of view of those experiencing it. Common methods are focus groups, individual interviews (unstructured or semistructured), and participation/observations. Sample sizes are small and are determined when data saturation is achieved. Data saturation is reached when the researcher identifies that no new themes emerge and redundancy is occurring. Synthesis is used in data analysis. Often a starting point for studies when little research exists; may use results to design empirical studies. The researcher describes, analyzes, and interprets reports, descriptions, and observations from participants.  
 Go to Section II: Qualitative
- **Mixed methods** (results reported both numerically and narratively)  
 Both quantitative and qualitative methods are used in the study design. Using both approaches, in combination, provides a better understanding of research problems than using either approach alone. Sample sizes vary based on methods used. Data collection involves collecting and analyzing both quantitative and qualitative data in a single study or series of studies. Interpretation is continual and can influence stages in the research process.  
 Go to Section I for Quantitative components and Section II for Qualitative components

## Johns Hopkins Nursing Evidence-Based Practice Appendix E: Research Evidence Appraisal Tool

<b>Section I: Quantitative</b>			
<b>Level of Evidence (Study Design)</b>			
A. Is this a report of a single research study?		<input type="checkbox"/> Yes	<input type="checkbox"/> No Go to B.
1. Was there manipulation of an independent variable?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
2. Was there a control group?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
3. Were study participants randomly assigned to the intervention and control groups?		<input type="checkbox"/> Yes	<input type="checkbox"/> No
If Yes to questions 1, 2, and 3, this is a randomized controlled trial (RCT) or experimental study.	<input type="checkbox"/> LEVEL I		
If Yes to questions 1 and 2 and No to question 3, or Yes to question 1 and No to questions 2 and 3, this is quasi-experimental (some degree of investigator control, some manipulation of an independent variable, lacks random assignment to groups, and may have a control group).	<input type="checkbox"/> LEVEL II		
If No to questions 1, 2, and 3, this is nonexperimental (no manipulation of independent variable; can be descriptive, comparative, or correlational; often uses secondary data).	<input type="checkbox"/> LEVEL III		
Study Findings That Help Answer the EBP Question			
Complete the Appraisal of Quantitative Research Studies section.			

## Johns Hopkins Nursing Evidence-Based Practice Appendix E: Research Evidence Appraisal Tool

<p>B. Is this a summary of multiple sources of research evidence?</p>		<input type="checkbox"/> Yes Continue	<input type="checkbox"/> No Go to Appendix F
<p>1. Does it employ a comprehensive search strategy and rigorous appraisal method?</p> <p style="margin-top: 10px;">If this study includes research, nonresearch, and experiential evidence, it is an integrative review. See Appendix F.</p>		<input type="checkbox"/> Yes	<input type="checkbox"/> No Go to Appendix F
<p>2. For systematic reviews and systematic reviews with meta-analysis (see descriptions below):</p> <ul style="list-style-type: none"> <li>a. Are all studies included RCTs?</li> <li>b. Are the studies a combination of RCTs and quasi-experimental, or quasi-experimental only?</li> <li>c. Are the studies a combination of RCTs, quasi-experimental, and nonexperimental, or non-experimental only?</li> </ul> <p style="margin-top: 10px;">A <u>systematic review</u> employs a search strategy and a rigorous appraisal method, but does not generate an effect size.</p> <p>A <u>meta-analysis</u>, or systematic review with meta-analysis, combines and analyzes results from studies to generate a new statistic: the effect size.</p>	<input type="checkbox"/> Level I  <input type="checkbox"/> Level II  <input type="checkbox"/> Level III		
<p>Study Findings That Help Answer the EBP Question</p>   			
<p>Complete the Appraisal of Systematic Review (With or Without a Meta-Analysis) section.</p>			

## Johns Hopkins Nursing Evidence-Based Practice Appendix E: Research Evidence Appraisal Tool

Appraisal of Quantitative Research Studies			
Does the researcher identify what is known and not known about the problem and how the study will address any gaps in knowledge?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Was the purpose of the study clearly presented?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Was the literature review current (most sources within the past five years or a seminal study)?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Was sample size sufficient based on study design and rationale?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
If there is a control group:			
• Were the characteristics and/or demographics similar in both the control and intervention groups?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
• If multiple settings were used, were the settings similar?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
• Were all groups equally treated except for the intervention group(s)?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Are data collection methods described clearly?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Were the instruments reliable (Cronbach's $\alpha$ [alpha] > 0.70)?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Was instrument validity discussed?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
If surveys or questionnaires were used, was the response rate $\geq$ 25%?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Were the results presented clearly?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
If tables were presented, was the narrative consistent with the table content?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Were study limitations identified and addressed?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Were conclusions based on results?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Go to Quality Rating for Quantitative Studies section			
Appraisal of Systematic Review (With or Without Meta-Analysis)			
Were the variables of interest clearly identified?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Was the search comprehensive and reproducible?			
• Key search terms stated	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
• Multiple databases searched and identified	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
• Inclusion and exclusion criteria stated	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Was there a flow diagram that included the number of studies eliminated at each level of review?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	



## Johns Hopkins Nursing Evidence-Based Practice Appendix E: Research Evidence Appraisal Tool

Were details of included studies presented (design, sample, methods, results, outcomes, strengths, and limitations)?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Were methods for appraising the strength of evidence (level and quality) described?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Were conclusions based on results?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
= Results were interpreted.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
= Conclusions flowed logically from the interpretation and systematic review question.	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Did the systematic review include a section addressing limitations and how they were addressed?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<b>Quality Rating for Quantitative Studies</b>		
Complete quality rating for quantitative studies section.		
<p>Circle the appropriate quality rating below</p> <p><b>A. High quality:</b> Consistent, generalizable results; sufficient sample size for the study design; adequate control; definitive conclusions; consistent recommendations based on comprehensive literature review that includes thorough reference to scientific evidence.</p> <p><b>B. Good quality:</b> Reasonably consistent results; sufficient sample size for the study design; some control, and fairly definitive conclusions; reasonably consistent recommendations based on fairly comprehensive literature review that includes some reference to scientific evidence.</p> <p><b>C. Low quality or major flaws:</b> Little evidence with inconsistent results; insufficient sample size for the study design; conclusions cannot be drawn.</p>		
<b>Section II: Qualitative</b>		
<b>Level of Evidence (Study Design)</b>		
A. Is this a report of a single qualitative research study?	<input type="checkbox"/> Yes Level III	<input type="checkbox"/> No Go to Section II. B
Study Findings That Help Answer the EBP Question		
Complete the Appraisal of Single Qualitative Research Study section.		

## Johns Hopkins Nursing Evidence-Based Practice Appendix E: Research Evidence Appraisal Tool

Appraisal of a Single Qualitative Research Study		
Was there a clearly identifiable and articulated:		
• Purpose?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
• Research question?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
• Justification for method(s) used?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
• Phenomenon that is the focus of the research?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Were study sample participants representative?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Did they have knowledge of or experience with the research area?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Were participant characteristics described?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Was sampling adequate, as evidenced by achieving saturation of data?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Data analysis:		
• Was a verification process used in every step by checking and confirming with participants the trustworthiness of analysis and interpretation?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
• Was there a description of how data were analyzed (i.e., method), by computer or manually?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Do findings support the narrative data (quotes)?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Do findings flow from research question to data collected to analysis undertaken?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Are conclusions clearly explained?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Go to Quality Rating for Qualitative Studies section.		
B. For summaries of multiple qualitative research studies (meta-synthesis), was a comprehensive search strategy and rigorous appraisal method used?	<input type="checkbox"/> Yes Level III	<input type="checkbox"/> No Go to Appendix F.
Study Findings That Help Answer the EBP Question		
Complete the Appraisal of Meta-Synthesis Studies section.		

## Johns Hopkins Nursing Evidence-Based Practice Appendix E: Research Evidence Appraisal Tool

Appraisal of Meta-Synthesis Studies		
Were the search strategy and criteria for selecting primary studies clearly defined?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Were findings appropriate and convincing?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Was a description of methods used to:		
• Compare findings from each study?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
• Interpret data?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Did synthesis reflect:		
• New insights?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
• Discovery of essential features of phenomena?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
• A fuller understanding of the phenomena?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Was sufficient data presented to support the interpretations?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Complete Quality Rating for Qualitative Studies section.		
Quality Rating for Qualitative Studies		

Circle the appropriate quality rating below

No commonly agreed-on principles exist for judging the quality of qualitative studies. It is a subjective process based on the extent to which study data contributes to synthesis and how much information is known about the researchers' efforts to meet the appraisal criteria.

*For meta-synthesis, there is preliminary agreement that quality assessments should be made before synthesis to screen out poor-quality studies<sup>2</sup>.*

**A/B High/Good quality** is used for single studies and meta-syntheses<sup>2</sup>.

The report discusses efforts to enhance or evaluate the quality of the data and the overall inquiry in sufficient detail; and it describes the specific techniques used to enhance the quality of the inquiry. Evidence of some or all of the following is found in the report:

- **Transparency:** Describes how information was documented to justify decisions, how data were reviewed by others, and how themes and categories were formulated.
- **Diligence:** Reads and rereads data to check interpretations; seeks opportunity to find multiple sources to corroborate evidence.
- **Verification:** The process of checking, confirming, and ensuring methodologic coherence.
- **Self-reflection and self-scrutiny:** Being continuously aware of how a researcher's experiences, background, or prejudices might shape and bias analysis and interpretations.
- **Participant-driven inquiry:** Participants shape the scope and breadth of questions; analysis and interpretation give voice to those who participated.
- **Insightful interpretation:** Data and knowledge are linked in meaningful ways to relevant literature.

**C Lower-quality studies** contribute little to the overall review of findings and have few, if any, of the features listed for High/Good quality.

## Johns Hopkins Nursing Evidence-Based Practice Appendix E: Research Evidence Appraisal Tool

<b>Section III: Mixed Methods</b>		
<b>Level of Evidence (Study Design)</b>		
<p>You will need to appraise both the quantitative and qualitative parts of the study independently, before appraising the study in its entirety.</p>		
<p>1. Evaluate the quantitative portion of the study using Section I. Insert here the level of evidence and overall quality for this part:</p>	Level _	Quality _
<p>2. Evaluate the qualitative part of the study using Section II. Insert here the level of evidence and overall quality for this part:</p>	Level _	Quality _
<p>3. To determine the level of evidence, circle the appropriate study design:</p> <ul style="list-style-type: none"> <li>(a) Explanatory sequential designs collect quantitative data first, followed by the qualitative data; and their purpose is to explain quantitative results using qualitative findings. The level is determined based on the level of the quantitative part.</li> <li>(b) Exploratory sequential designs collect qualitative data first, followed by the quantitative data; and their purpose is to explain qualitative findings using the quantitative results. The level is determined based on the level of the qualitative part, and it is always Level III.</li> <li>(c) Convergent parallel designs collect the qualitative and quantitative data concurrently for the purpose of providing a more complete understanding of a phenomenon by merging both datasets. These designs are Level III.</li> <li>(d) Multiphase designs collect qualitative and quantitative data over more than one phase, with each phase informing the next phase. These designs are Level III.</li> </ul>		
<p>Study Findings That Help Answer the EBP Question</p>		
<p>Use the Appraisal of Mixed Methods Studies section.</p>		

## Johns Hopkins Nursing Evidence-Based Practice Appendix E: Research Evidence Appraisal Tool

Appraisal of Mixed Methods Studies <sup>2</sup>			
Was the mixed-methods research design relevant to address the quantitative and qualitative research questions (or objectives)?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Was the research design relevant to address the quantitative and qualitative aspects of the mixed-methods question (or objective)?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
For convergent parallel designs, was the integration of quantitative and qualitative data (or results) relevant to address the research question or objective?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
For convergent parallel designs, were the limitations associated with the integration (for example, the divergence of qualitative and quantitative data or results) sufficiently addressed?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Quality Rating for Mixed-Methods Studies			
Circle the appropriate quality rating below			
<p>A <b>High quality:</b> Contains high-quality quantitative and qualitative study components; highly relevant study design; relevant integration of data or results; and careful consideration of the limitations of the chosen approach.</p> <p>B <b>Good quality:</b> Contains good-quality quantitative and qualitative study components; relevant study design; moderately relevant integration of data or results; and some discussion of limitations of integration.</p> <p>C <b>Low quality or major flaws:</b> Contains low quality quantitative and qualitative study components; study design not relevant to research questions or objectives; poorly integrated data or results; and no consideration of limits of integration.</p>			

<sup>1</sup> [https://www.york.ac.uk/rd/steve/ISSI/WebHelp/E\\_4\\_ASSESSMENT\\_OF\\_QUALITATIVE\\_RESEARCH.htm](https://www.york.ac.uk/rd/steve/ISSI/WebHelp/E_4_ASSESSMENT_OF_QUALITATIVE_RESEARCH.htm)

<sup>2</sup> Adapted from Polit & Beck (2017).

<sup>3</sup> National Collaborating Centre for Methods and Tools. (2015). *Appraising Qualitative, Quantitative, and Mixed Methods Studies included in Mixed Studies Reviews: The MMAT*. Hamilton, ON: McMaster University. (Updated 20 July, 2015) Retrieved from <http://www.nccmt.ca/resources/search/232>

**Appendix F**

**Johns Hopkins Non-Research Evidence Appraisal Tool**

Johns Hopkins Nursing Evidence-Based Practice

**Appendix F  
Non-Research Evidence Appraisal**

<b>Evidence level and quality rating:</b>	
Article title:	Number:
Author(s):	Publication date:
Journal:	
Setting:	Sample (composition and size):
Does this evidence address my EBP question? <input type="checkbox"/> Yes <input type="checkbox"/> No- <i>Do not proceed with appraisal of this evidence</i>	

<p><b>▢ Clinical Practice Guidelines LEVEL IV</b> Systematically developed recommendations from nationally recognized experts based on research evidence or expert consensus panel</p> <p><b>▢ Consensus or Position Statement LEVEL IV</b> Systematically developed recommendations, based on research and nationally recognized expert opinion, that guide members of a professional organization in decision-making for an issue of concern</p>		
▪ Are the types of evidence included identified?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
▪ Were appropriate stakeholders involved in the development of recommendations?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
▪ Are groups to which recommendations apply and do not apply clearly stated?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
▪ Have potential biases been eliminated?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
▪ Does each recommendation have an identified level of evidence stated?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
▪ Are recommendations clear?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Findings That Help Answer the EBP Question		
<p><b>Complete the corresponding quality rating section.</b></p>		

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**Appendix F**  
**Non-Research Evidence Appraisal**

<p>▢ <b>Literature review LEVEL V</b> Summary of selected published literature including scientific and nonscientific such as reports of organizational experience and opinions of experts</p> <p>▢ <b>Integrative review LEVEL V</b> Summary of research evidence and theoretical literature; analyzes, compares themes, notes gaps in the selected literature</p>		
• Is subject matter to be reviewed clearly stated?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
• Is literature relevant and up-to-date (most sources are within the past five years or classic)?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
• Of the literature reviewed, is there a meaningful analysis of the conclusions across the articles included in the review?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
• Are gaps in the literature identified?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
• Are recommendations made for future practice or study?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Findings That Help Answer the EBP Question		
Complete the corresponding quality rating section.		

<p>▢ <b>Expert opinion LEVEL V</b> Opinion of one or more individuals based on clinical expertise</p>		
• Has the individual published or presented on the topic?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
• Is the author's opinion based on scientific evidence?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
• Is the author's opinion clearly stated?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
• Are potential biases acknowledged?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Findings That Help Answer the EBP Question		
Complete the corresponding quality rating section.		

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**Appendix F**  
**Non-Research Evidence Appraisal**

<p><b>Organizational Experience</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Quality improvement LEVEL V Cyclical method to examine workflows, processes, or systems with a specific organization</li> <li><input type="checkbox"/> Financial evaluation LEVEL V Economic evaluation that applies analytic techniques to identify, measure, and compare the cost and outcomes of two or more alternative programs or interventions</li> <li><input type="checkbox"/> Program evaluation LEVEL V Systematic assessment of the processes and/or outcomes of a program; can involve both quantitative and qualitative methods</li> </ul>			
Setting:		Sample Size/Composition:	
<input type="checkbox"/> Was the aim of the project clearly stated?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
<input type="checkbox"/> Was the method fully described?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
<input type="checkbox"/> Were process or outcome measures identified?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
<input type="checkbox"/> Were results fully described?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
<input type="checkbox"/> Was interpretation clear and appropriate?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
<input type="checkbox"/> Are components of cost/benefit or cost effectiveness analysis described?	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Findings That Help Answer the EBP Question			
<b>Complete the corresponding quality rating section.</b>			



Johns Hopkins Nursing Evidence-Based Practice

**Appendix F**  
**Non-Research Evidence Appraisal**

<input type="checkbox"/> <b>Case report LEVEL V</b> In-depth look at a person or group or another social unit		
<input type="checkbox"/> Is the purpose of the case report clearly stated?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<input type="checkbox"/> Is the case report clearly presented?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<input type="checkbox"/> Are the findings of the case report supported by relevant theory or research?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<input type="checkbox"/> Are the recommendations clearly stated and linked to the findings?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Findings That Help Answer the EBP Question		
Complete the corresponding quality rating.		

<b>Community standard, clinician experience, or consumer preference LEVEL V</b> <input type="checkbox"/> <b>Community standard:</b> Current practice for comparable settings in the community <input type="checkbox"/> <b>Clinician experience:</b> Knowledge gained through practice experience <input type="checkbox"/> <b>Consumer preference:</b> Knowledge gained through life experience			
Information Source(s)		Number of Sources	
<input type="checkbox"/> Source of information has credible experience	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
<input type="checkbox"/> Opinions are clearly stated	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
<input type="checkbox"/> Evidence obtained is consistent	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A
Findings That Help You Answer the EBP Question			
Complete the corresponding quality rating section.			

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## Appendix F

### Non-Research Evidence Appraisal

Quality Rating for Clinical Practice Guidelines, Consensus, or Position Statements (Level IV)
<p><b>A High quality</b> Material officially sponsored by a professional, public, or private organization or a government agency; documentation of a systematic literature search strategy; consistent results with sufficient numbers of well-designed studies; criteria-based evaluation of overall scientific strength and quality of included studies and definitive conclusions; national expertise clearly evident; developed or revised within the past five years.</p> <p><b>B Good quality</b> Material officially sponsored by a professional, public, or private organization or a government agency; reasonably thorough and appropriate systematic literature search strategy; reasonably consistent results, sufficient numbers of well-designed studies; evaluation of strengths and limitations of included studies with fairly definitive conclusions; national expertise clearly evident; developed or revised within the past five years.</p> <p><b>C Low quality or major flaw</b> Material not sponsored by an official organization or agency; undefined, poorly defined, or limited literature search strategy; no evaluation of strengths and limitations of included studies; insufficient evidence with inconsistent results; conclusions cannot be drawn; not revised within the past five years.</p>
Quality Rating for Organizational Experience (Level V)
<p><b>A High quality</b> Clear aims and objectives; consistent results across multiple settings; formal quality improvement or financial evaluation methods used; definitive conclusions; consistent recommendations with thorough reference to scientific evidence.</p> <p><b>B Good quality</b> Clear aims and objectives; formal quality improvement or financial evaluation methods used; consistent results in a single setting; reasonably consistent recommendations with some reference to scientific evidence.</p> <p><b>C Low quality or major flaws</b> Unclear or missing aims and objectives; inconsistent results; poorly defined quality; improvement/financial analysis method; recommendations cannot be made.</p>
Quality Rating for Case Report, Integrative Review, Literature Review, Expert Opinion, Community Standard, Clinician Experience, Consumer Preference (Level V)
<p><b>A High quality</b> Expertise is clearly evident, draws definitive conclusions, and provides scientific rationale; thought leader in the field.</p> <p><b>B Good quality</b> Expertise appears to be credible, draws fairly definitive conclusions, and provides logical argument for opinions.</p> <p><b>C Low quality or major flaws</b> Expertise is not discernable or is dubious; conclusions cannot be drawn.</p>

Appendix G

Evidence table

Purpose of Article or Review	Design/ Method	Sample/ Setting	Conceptual Framework	Major Variables Studied and their Definitions)	Measurement/ Data Analysis	Findings	Critical Appraisal Tool and Rating/ Worth to Practice/ Strengths and Weaknesses/ Recommendations
Agarwal, R., Sands, D., & Schneider, J. (2010). Quantifying the economic impact of communication inefficiencies in U.S. hospitals. <i>Journal of Healthcare Management</i> , 55(4), 265–281.							
To develop a model for quantifying the economic burden of poor communication on hospital	<p><b>Design:</b> Multi-stage qualitative study (three stages)</p> <p><b>Method</b></p> <ol style="list-style-type: none"> <li>1. Literature review</li> <li>2. Stakeholder Interviews</li> <li>3. Development of a quantitative model</li> </ol>	<p><b>Sample</b> Unknown # “Interviewees included chief nursing officers (CNOs), chief information officers (CIOs), chief medical officers (CMOs), physicians, nurses, and hospital chief executive officers (CEOs).”</p> <p><b>Setting:</b> Seven short term/acute-care hospitals that varied in size, revenue and location (urban and suburban).</p>	None noted	<p><b>Independent Variable:</b></p> <ul style="list-style-type: none"> <li>• MD time,</li> <li>• RN time,</li> <li>• length of stay,</li> <li>• medical errors,</li> <li>• stress,</li> <li>• job satisfaction</li> <li>• patient experience</li> </ul> <p><b>Dependent Variable(s)</b></p> <ul style="list-style-type: none"> <li>• resource utilization,</li> <li>• operational effectiveness,</li> <li>• work life quality</li> <li>• service quality</li> </ul>	<p><b>Measurement</b> Hour-long structured interviews</p> <p><b>Data analysis</b> Two interviewers independently extracted themes that were subsequently compared to validate and triangulate findings.</p>	The authors identified specific metrics ( MD time, RN time, length of stay, medical errors, stress, job satisfaction and patient experience) for resource utilization, operational effectiveness, work life quality and service quality	<p><b>Rating:</b> Level III A/B (High/ Good Quality)</p> <p><b>Worth to practice</b> One of the only papers in the literature that quantifies the effects of poor communication in financial terms</p> <p><b>Feasibility</b> Strong financial analysis based on literature review and expert opinion</p> <p><b>Strengths</b> Agreement in the themes extracted was 92 percent for all interviews.</p> <p><b>Weaknesses</b> Older study (2010), Unknown number of participants. No theory for conceptual framework</p> <p><b>Conclusions</b> This study is useful as it places a dollar amount on wasted communication, especially for increased length of stay.</p> <p><b>Recommendations:</b> Further studies to check assumptions/ conclusions to demonstrate if their financial predictions were accurate.</p>

Purpose of Article or Review	Design/ Method	Sample/ Setting	Conceptual Framework	Major Variables Studied and their Definitions)	Measurement/ Data Analysis	Findings	Critical Appraisal Tool and Rating/ Worth to Practice/ Strengths and Weaknesses/ Recommendations
Bautista, R., Rosenthal, S., Lin, T., & Theng, Y. (2018). Predictors and outcomes of nurses use of smartphones for work purposes. <i>Computers in Human Behavior</i> , 84, 360-374.							
To address a research gap by developing and testing a model to analyze nurses use of personal smartphones.	<p><b>Design</b> Quantitative survey</p> <p><b>Method</b> A theory driven (structural equation modeling) analysis of surveys</p>	<p><b>Sample</b> 517 staff nurses</p> <p><b>Setting</b> 19 tertiary hospitals in the Philippines</p>	Theory of planned behavior, organizational support theory and IT consumerization theory	<p><b>Independent Variable:</b> Survey to measure how nurses use their phones</p> <p><b>Dependent Variable(s)</b> Productivity of nurses</p>	<p><b>Measurement</b> Factor analysis, Kaiser-Meyer-Olkin (KMO) test for sampling adequacy and Bartlett’s test of sphericity.</p> <p><b>Data Analysis</b> SPSS Statistics 23 program and Mplus 7</p>	<p>Inductive norm, descriptive norm and perceived behavioral control were positively associated with intention to use smartphones for work purposes. And it was positively associated with perceived work productivity and perceived quality of care.</p> <p>Six out of 11 hypotheses were supported with statistical significance (<math>p &lt; 0.001</math>, <math>p = 0.04</math>, <math>p = 0.02</math>, <math>p &lt; 0.0001</math> and <math>p 0.02</math>)</p>	<p><b>Rating</b> Level II A/B (High/Good Quality)</p> <p><b>Worth to practice</b> Demonstrates the value of smartphones to nurses in clinical practice</p> <p><b>Feasibility</b> Strong, theory based quantitative study</p> <p><b>Strengths</b> Having a theory-based approach to the study (in the conceptual framework and the measurement strategy) was a strength</p> <p><b>Weaknesses</b> No real description of the survey weakens the study.</p> <p><b>Conclusion</b> Concluded with statistical significance that nurses perceived the use of smartphones at work improved their productivity and quality of care</p> <p><b>Recommendations</b> Further analysis if the positive results of nurses use of <i>personal</i> smart phones is replicated in their attitudes to and use of <i>employer provided</i> smartphones.</p>

Purpose of Article or Review	Design/ Method	Sample/ Setting	Conceptual Framework	Major Variables Studied and their Definitions)	Measurement/ Data Analysis	Findings	Critical Appraisal Tool and Rating/ Worth to Practice/ Strengths and Weaknesses/ Recommendations
Chatterjee, S., Chakraborty, S., Sarker, S., Sarker, S2., & Lau, F. (2009). Examining the success factors for mobile work in healthcare: A deductive study. <i>Decision Support Systems</i> , 46, 620-633.							
To identify key factors in the literature that influence the success of “mobile work” in healthcare	<p><b>Design</b> Deductive literature review</p> <p>Note: while the authors stated this was a deductive review, it appears to resemble more a qualitative study.</p> <p><b>Method</b> “a consolidated review of literature in the area of mobile work in healthcare”</p>	<p><b>Sample</b> 70 articles</p> <p><b>Setting</b> Pub med and Ovid search, key terms utilized, limited to four years, English language only, irrelevant articles excluded</p>	Delone and Mclean’s Model of Information Systems Success	<p><b>Independent Variables:</b></p> <ul style="list-style-type: none"> <li>- data processing</li> <li>- information access</li> <li>- communicability</li> <li>- portability</li> <li>- task structure</li> <li>- task urgency</li> <li>- temporal mobility</li> <li>- spatial mobility</li> <li>- contextual mobility</li> <li>- information complexity</li> <li>- system reliability</li> <li>- system support</li> <li>- use</li> <li>- satisfaction</li> </ul> <p><b>Dependent Variable(s)use</b></p> <ul style="list-style-type: none"> <li>- satisfaction</li> <li>- net benefits</li> </ul>	<p><b>Measurement</b> Two coders used a standard coding scheme reflecting the constructs of the model. Interrater reliability assessed using Cohen’s kappa</p> <p><b>Data Analysis</b> To assess the impact of the independent variable on the dependent variable, the authors “conceptualize d each relationship in the model as a variance theory relationship where independent variables were individually considered as necessary and sufficient”</p>	Mixed support for propositions in the literature. One key finding was that high levels of data processing is not needed by healthcare workers, as simple communication is what is most sought after in mobile devices.	<p><b>Rating:</b> Level III A/B (High/ Good Quality)</p> <p><b>Worth to practice</b> Provides strong rationale for the benefits of healthcare mobile technology and lists valued capabilities</p> <p><b>Feasibility</b> Provides previously unknown information about value of mobility in healthcare</p> <p><b>Strengths,</b> Strong literature review methodology utilized using a theory drive approach</p> <p><b>Weaknesses,</b> Older review (2009)</p> <p><b>Conclusions</b> Healthcare workers would be positively influenced by the capabilities of mobile work including the ability to have data processing, access to information, communicability, portability, structure to tasks, spatial mobility, urgency of information, system reliability and support.</p> <p><b>Recommendations</b> Further studies on the benefits of the other capabilities of smartphones</p>

Purpose of Article or Review	Design/ Method	Sample/ Setting	Conceptual Framework	Major Variables Studied and their Definitions)	Measurement/ Data Analysis	Findings	Critical Appraisal Tool and Rating/ Worth to Practice/ Strengths and Weaknesses/ Recommendations
Hoonakker, P., Carayon, P., & Cartmill, R. (2017). The impact of secure messaging on workflow in primary care: Results of a multiple-case, multiple-method study. <i>International Journal of Medical Informatics</i> , 100, 63–76.							
To examine the impact of secure messaging in primary care clinics (between staff, providers and patients)	<p><b>Design</b> Mixed method (quantitative and qualitative) study</p> <p><b>Method</b> Observation, interviews and survey</p>	<p><b>Sample</b> 40 observations/ interviews over 60 hours and 58 surveys</p> <p><b>Setting</b> Five clinics in Madison, Wisconsin</p>	None noted	<p><b>Independent Variable:</b> Impact of having a secure messaging application</p> <p><b>Dependent Variable(s)</b> - quality of care - patient safety - end user satisfaction</p>	<p><b>Measurement</b> Pre-visit questionnaires, observation forms and surveys</p> <p><b>Analysis</b> For observations/ interviews: analysis in Dedoose data analysis program</p> <p>For Surveys: chi-square-tests used to determine differences</p>	<p>Convenience, ease of patient communication, ease of answering simple questions, workflow efficiencies, and improved information flow were all facilitators from the technology.</p> <p>Volume of messages, lack of contextual information, and workflow interruptions were all classed as barriers</p>	<p><b>Rating</b> Level II A/B High/Good quality</p> <p><b>Worth to practice</b> Highlights the pros, cons and potential pitfalls of healthcare secure messaging</p> <p><b>Feasibility</b> Feasibility of secure messaging depends on how it is implemented</p> <p><b>Strengths,</b> Provides detailed arguments about the benefits of secure messaging in in healthcare. Provided hyperlink to data collections tools. Identified statistical significance between clinician and non-clinician perceptions of the technology</p> <p><b>Weaknesses,</b> Limited to outpatient clinics so hospital workflows not discussed. Survey instrument not fully validated.</p> <p><b>Conclusion</b> Secure messaging is a tool that has the potential to improve communication and information flow. However, this is dependent on the way it is implemented and used.</p> <p><b>Recommendations</b> Further studies to determine if the implementation or policy decisions were the reasons for different opinions of staff, providers and patients.</p>

Purpose of Article or Review	Design/ Method	Sample/ Setting	Conceptual Framework	Major Variables Studied and their Definitions)	Measurement/ Data Analysis	Findings	Critical Appraisal Tool and Rating/ Worth to Practice/ Strengths and Weaknesses/ Recommendations
Lo, V., Wu, R. C., Morra, D., Lee, L., & Reeves, S. (2012). The use of smartphones in general and internal medicine units: A boon or a bane to the promotion of interprofessional collaboration? <i>Journal of Interprofessional Care</i> , 26(4), 276–282.							
To determine the perceptions of internal medicine staff about the use of smartphones and a web paging system after they were implemented in their hospitals.	<p><b>Design</b> An explanatory case study approach</p> <p><i>Note:</i> While the authors identified this as a case study approach, the methodology signifies a qualitative study</p> <p><b>Method</b> In- depth semi-structured interviews</p>	<p><b>Sample</b> 31 staff members, male and female with a range of ages: 15 registered nurses, eight physicians, four social workers, three pharmacists and an occupational therapist.</p> <p><b>Setting</b> Internal Medicine Departments of two Canadian hospitals</p>	None noted	<p><b>Independent Variable:</b> Introduction of smartphone technology in two teaching hospitals</p> <p><b>Dependent Variable(s)</b> Perceptions of the clinicians about the use and satisfaction with the smartphones</p>	<p><b>Measurement</b> Open coding of data. Samples read by three members of the research team independently</p> <p><b>Analysis</b> Conducted through NVivo8 program.</p>	Positive feedback included satisfaction with the use of emails for nonurgent issues with the capability to make phone calls for more urgent issues. Negative elements included the unsuitability of smartphones in some communication contexts and the negative impact of discrepancies between clinicians with the communication modes	<p><b>Rating</b> Level III A/B (High/ Good quality)</p> <p><b>Worth to practice</b> Robust discussion regarding the benefits of technology improving clinical communication in a cross-section of clinicians</p> <p><b>Feasibility</b> In-depth interviews provided deep insight into the clinician’s perspective</p> <p><b>Strengths</b> Strong narrative accounts/direct quotes</p> <p><b>Weaknesses,</b> Short background, thematic analysis relayed only two main themes</p> <p><b>Conclusion</b> Future technology interventions in should take into consideration how communication mediums and situational contexts (e.g. urgency) impact interprofessional interactions.</p> <p><b>Recommendations</b> Future studies into the creation of flexible communication environments to mitigate the negative effects of communication technologies</p>

Purpose of Article or Review	Design/ Method	Sample/ Setting	Conceptual Framework	Major Variables Studied and their Definitions)	Measurement/ Data Analysis	Findings	Critical Appraisal Tool and Rating/ Worth to Practice/ Strengths and Weaknesses/ Recommendations
<p>Martin, G., Khajuria, A., Arora, S., King, D., Ashrafian, H., &amp; Darzi, A. (2019). The impact of mobile technology on teamwork and communication in hospitals: a systematic review. <i>Journal of the American Medical Informatics Association</i>, 26(4), 339–355.</p>							
<p>To summarize the quality and breadth of evidence for the impact of mobile technologies on communication and teamwork in hospitals.</p>	<p><b>Design:</b> Systematic Review of interventional and non-interventional studies rated from Good to Poor</p> <p><b>Method:</b> Electronic Data base search with review of high vs low quality studies</p>	<p><b>Sample</b> 8,072 papers reviewed with 38 publications from 30 studies included from 2007-2017</p> <p><b>Setting</b> Search of MEDLINE, PsycINFO, EMBASE, CINAHL Plus, HMIC, Cochrane Library and National Institute of Health (NIH) Research Health Technology Assessment</p>	<p>Authors followed PRISMA guidelines</p>	<p><b>Independent Variable:</b> Mobile technologies in healthcare teams</p> <p><b>Dependent Variable(s)</b></p> <ul style="list-style-type: none"> <li>- communication</li> <li>- teamwork</li> <li>- workflow efficiency,</li> <li>- improved quality of communication</li> <li>- ease of non-urgent communication</li> <li>- disruption of clinical workflows</li> <li>- improved team relationships.</li> </ul>	<p>Measurement Data summarized, presented in a table format and grouped into six categories</p> <p>Data Analysis Two reviewers independently reviewed titles/ abstracts for eligibility against specified inclusion and exclusion criteria.</p> <p>Only those papers considered relevant advanced to full text review</p>	<p>Observations of the benefits of mobile technology including workflow efficiency, improved quality of communication, ease of non-urgent communications, less disruption of clinical workflows and improved team relationships.</p>	<p><b>Rating:</b> Level II A (High quality)</p> <p><b>Worth to practice</b> Valuable article providing in-depth knowledge on all available levels of evidence with recognition of the lack of high-quality studies/evidence in this field</p> <p><b>Feasibility</b> Robust systematic review of 8000+ articles and subsequent detailed assessment of 30 studies</p> <p><b>Strengths,</b> Differentiation between high- and low-quality studies. Cohens Kappa used to ensure interrater reliability</p> <p><b>Weaknesses,</b> Limited background information given in introduction section</p> <p><b>Conclusion</b> The lack of high-quality evidence in the area of mobility in clinical communication is significant</p> <p><b>Recommendation</b> Further high-quality studies on the</p>



Purpose of Article or Review	Design/ Method	Sample/ Setting	Conceptual Framework	Major Variables Studied and their Definitions)	Measurement/ Data Analysis	Findings	Critical Appraisal Tool and Rating/ Worth to Practice/ Strengths and Weaknesses/ Recommendations
					<p>Cohen’s kappa agreement was calculated for each stage of screening and review with disagreements resolved through consensus.</p> <p>The PRISMA Diagram was used for study inclusion</p> <p>Key indicators were quality assessed through the NIH Quality Assessment Tool and the World Health Organizations mobile health evidence reporting and assessment (mERA) Checklist</p>		<p>design and implementation of mobile technology to meet healthcare’s needs.</p>

Purpose of Article or Review	Design/ Method	Sample/ Setting	Conceptual Framework	Major Variables Studied and their Definitions)	Measurement/ Data Analysis	Findings	Critical Appraisal Tool and Rating/ Worth to Practice/ Strengths and Weaknesses/ Recommendations
Mehrzad, R., & Barza, M. (2015). Are physician pagers an outmoded technology? <i>Technology &amp; Health Care</i> , 23(3), 233–241.							
To determine the efficiency and financial costs of using pagers in hospitals	<p><b>Design</b> Quantitative Study</p> <p><b>Method</b> Survey and financial analysis</p>	<p><b>Sample</b> Seventy clinicians (10 attending physicians, 30 medical residents, 20 registered nurses, and 10 clinical pharmacists)</p> <p><b>Setting</b> A community hospital in Boston, Massachusetts.</p>	None noted	<p><b>Independent Variable:</b> Use of pagers technology</p> <p><b>Dependent Variable(s)</b></p> <ul style="list-style-type: none"> <li>- efficiency</li> <li>- productivity</li> <li>- cost</li> <li>- perception</li> </ul>	<p><b>Measurement</b> Survey data: mean and standard deviation analysis</p> <p>For financial data; costs calculated by mean time spent, pages sent and hourly salaries.</p> <p><b>Data Analysis</b> No data analysis tools noted in the paper</p>	<p>The authors discovered issues of unproductive time by physicians, nurses, and pharmacists, delayed ignored, or missed responses as well as a lack of urgency around paging as a communication method.</p> <p>Financially, pagers were found to be a costly technology and costly in the wasted time of the clinicians.</p>	<p><b>Rating</b> Level 5 A (financial analysis)</p> <p><b>Worth to practice</b> Valuable information related to inefficiencies of paging systems and resulting organization financial burden</p> <p><b>Feasibility</b> The extrapolation that wasted time equals an actual cost saving is weak.</p> <p><b>Strengths,</b> Amount of time wasted/cost of technology replacement analysis is strong.</p> <p><b>Weaknesses,</b> No details of the survey given, appears to be a survey of the number of times paged during the shift</p> <p><b>Conclusion</b> Pagers are inefficient and expensive technology which should be replaced with a direct phone calling system.</p> <p><b>Recommendation</b> The authors recommended time and motion studies to clearly define the financial cost of the wasted time utilizing pagers.</p>

Purpose of Article or Review	Design/ Method	Sample/ Setting	Conceptual Framework	Major Variables Studied and their Definitions)	Measurement/ Data Analysis	Findings	Critical Appraisal Tool and Rating/ Worth to Practice/ Strengths and Weaknesses/ Recommendations
Menon, R., & Rivett C. (2019). Time–motion analysis examining of the impact of Medic Bleep, an instant messaging platform, versus the traditional pager: A prospective pilot study. <i>Digital Health</i> , 5: 1–2.							
To compare the use of traditional pagers with a pilot clinical communication platform consisting of smart devices and an instant messaging application.	<p><b>Design</b> Mixed method study</p> <p><b>Method</b> Time and motion studies, interviews and survey</p>	<p><b>Setting</b> West Suffolk (United Kingdom) National Health Service Trust</p> <p><b>Sample</b> 181 participants from three clinical care areas (trauma, ortho and maternity), physician and nurse over two weeks with 90 and 86 points of interaction.</p>	None noted	<p><b>Independent Variables:</b></p> <ul style="list-style-type: none"> <li>- smart devices</li> <li>- instant messaging application</li> </ul> <p><b>Dependent Variable(s)</b></p> <ul style="list-style-type: none"> <li>- task duration</li> <li>- time savings</li> <li>- clinician perception</li> <li>- work prioritization</li> <li>- collaboration</li> <li>- medication administration</li> </ul>	<p><b>Measurement</b> Review of time and motion data, visual process maps well as face to face interviews and surveys</p> <p><b>Data Analysis</b> Quantitative analysis: R Project for Statistical Computing program and Welch’s two-sample <i>t</i>-test.</p> <p>Mean duration analyzed</p> <p>Visual process mapping conducted</p>	<p>A statistically significant reduction (<math>p &lt; 0.05</math>) in task-duration and time saved per shift (<math>p &lt; 0.05</math>) was noted.</p> <p>A perceived benefit from the team on work prioritization, collaboration and medication administration. Results of the task duration analysis was demonstrated on a Kernel density plot diagram</p>	<p><b>Rating</b> Level III A/ B (High/ Good Quality)</p> <p><b>Worth to practice</b> This study definitively demonstrates the value of clinical communication technology both quantitatively and qualitatively.</p> <p><b>Feasibility</b> Strong- time and motion studies with observers, and the qualitative elements make this a highly feasible result</p> <p><b>Strengths,</b> Observers for time and motion studies. Robust analysis of quantitative data</p> <p><b>Weaknesses,</b> No details of qualitative data analysis that resulted in their conclusions.</p> <p><b>Conclusion</b> There was a positive effect on task duration, efficiency and work environment but the authors state there is a need to replicate this study with a wider sample of participants</p> <p><b>Recommendation</b> Further studies on a larger sample size over a longer duration in more areas of the hospital setting</p>

Purpose of Article or Review	Design/ Method	Sample/ Setting	Conceptual Framework	Major Variables Studied and their Definitions)	Measurement/ Data Analysis	Findings	Critical Appraisal Tool and Rating/ Worth to Practice/ Strengths and Weaknesses/ Recommendations
Mickan, S., Atherton, H., Roberts, N.W., Heneghan, C., & Tilson, J. (2014). Use of handheld computers in clinical practice: a systematic review. <i>BMC Medical Informatics and Decision Making</i> , 14:56.							
To examine if smartphone and tablet use in the healthcare team improves team access to information and supports clinical decision making	<p><b>Design</b> Systematic review of Randomized Control Trials (RCTs) only</p> <p><b>Method</b> Detailed database search from 2001 to 2013</p>	<p><b>Sample</b> 3612 papers reviewed with 38 read, of which only seven met with inclusion criteria</p> <p><b>Setting</b> Search of Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, PsycINFO, EMBASE, Science Citation Index and Social Science Citation Index</p>	None	<p><b>Independent Variable:</b> Use of smartphones and tables in healthcare</p> <p><b>Dependent Variable(s)</b> - improvement in team access to information - support for clinical decision making</p>	<p><b>Measurement</b> Narrative approach to summarize evidence for effectiveness</p> <p><b>Data Analysis</b> The authors noted that “high levels of data heterogeneity and mixed data quality meant that statistical synthesis was not possible”, however, some statistical significance was noted.</p>	There is statistically significant proof ( $p < 0.05$ and $p < 0.01$ ) that handheld computers made synthesized information more available to clinicians and that this has the potential to improve clinical decision-making at the bedside	<p><b>Rating</b> Level I A (High quality) as it is a systematic review of RCTs.</p> <p><b>Worth to practice</b> Valuable information from the early use of handheld devices about their application to healthcare settings</p> <p><b>Feasibility</b> Strong search methodology and review process with interrater reliability noted.</p> <p><b>Strengths</b> Review of highest available level of evidence in the topic. Detailed analysis.</p> <p><b>Weaknesses,</b> Only available studies were on the use of PDAs – not smartphones/tablets</p> <p><b>Conclusion</b> The authors recommended further studies to determine if there are direct improvements in clinical outcomes and to review the conditions in which handheld computers have their best results.</p> <p><b>Recommendations</b> Conduct current (2020) systematic review of RCTs to add smartphones and tablets</p>

Purpose of Article or Review	Design/ Method	Sample/ Setting	Conceptual Framework	Major Variables Studied and their Definitions)	Measurement/ Data Analysis	Findings	Critical Appraisal Tool and Rating/ Worth to Practice/ Strengths and Weaknesses/ Recommendations
Motulsky, A., Wong, J., Cordeau, J.-P., Pomalaza, J., Barkun, J., Tamblyn, R., & Wong, J. (2017). Using mobile devices for inpatient rounding and handoffs: an innovative application developed and rapidly adopted by clinicians in a pediatric hospital. <i>Journal of the American Medical Informatics Association</i> , 24(e1), e69–e78.							
To describe the usage patterns and end-user satisfaction of a new application (handoff and rounding tool) as a mobile technology solution	<p><b>Design</b> Quantitative Survey</p> <p><b>Method</b> Questionnaire to describe user experience</p>	<p><b>Sample</b> 127 survey responses</p> <p><b>Setting</b> Pediatric and Neonatal Intensive Care (PICU and NICU) Units in McGill University in Montreal, Canada</p>	Davis’s Technology Acceptance Model	<p><b>Independent Variable:</b> Implementation of an electronic Handoff and rounding tool</p> <p><b>Dependent Variable(s)</b></p> <ul style="list-style-type: none"> <li>- usage after one year</li> <li>- end user satisfaction</li> </ul>	<p><b>Measurement</b> Usage patterns assessed using the Kruskal Wallis Test. Differences assessed using Wilcoxon Rank sum test.</p> <p><b>Data Analysis</b> All analysis was conducted in SAS 9.4 and Gephi 0.8.2 beta.</p>	<p>The authors found that the ICUs continued to use the application (app) one year after implementation, but the medical-surgical departments stopped after six months due to a lack of functionality for their workflows. Most physician and ‘some nurse’ participants wanted to keep using the app after implementation.</p> <p>On average, respondents were positive in their perceptions about the usability and impact of the application</p>	<p><b>Rating</b> Level III A/B (Good/High quality) (non-experimental study)</p> <p><b>Worth to practice</b> Useful article to determine the value of clinician specific applications on mobile devices</p> <p><b>Feasibility</b> Moderate given the non-users were not surveyed.</p> <p><b>Strengths</b> Data analysis and presentation was very strong in this article The survey questions were demonstrated in the article</p> <p><b>Weaknesses,</b> No viewpoint from clinicians who abandoned the application</p> <p><b>Conclusion</b> Usage varied by clinician group identified and a gap in the authors’ data collection was identified based on the weakness above.</p> <p><b>Recommendations</b> Studying the users who abandoned the app for their rationale and study of the different usage patterns in different units reflect different team-based work practices.</p>

Purpose of Article or Review	Design/ Method	Sample/ Setting	Conceptual Framework	Major Variables Studied and their Definitions)	Measurement/ Data Analysis	Findings	Critical Appraisal Tool and Rating/ Worth to Practice/ Strengths and Weaknesses/ Recommendations
<p>Patel, N., Siegler, J., Stromberg, N., Ravitz, N., &amp; Hanson, C. (2016). Perfect storm of inpatient communication needs and an innovative solution utilizing smartphones and secured messaging. <i>Applied Clinical Informatics</i>, 7: 777–789.</p>							
<p>To confirm the authors’ hypothesis that a mobile device with a secure messaging application would be an efficient and effective mode for non-urgent communication and care team co-ordination</p>	<p><b>Design</b> Quantitative study</p> <p><b>Method</b> Pre- and post-survey evaluations of a secure messaging application</p>	<p><b>Sample</b> Pre- 136 nurses and 93 physicians Post- 127 nurses and 83 physicians</p> <p><b>Setting</b> Four hospital units over a one-year period at the Hospital of University of Pennsylvania</p>	<p>None noted</p>	<p><b>Independent Variable:</b> The introduction of a mobile device with a secure messaging application</p> <p><b>Dependent Variable(s)\</b> - efficiency - effectiveness as a mode for non-urgent communication and care team co-ordination - disruptions</p>	<p><b>Measurement</b> Device and application usage as well as pre and post implementation survey</p> <p><b>Data analysis</b> Usage - data analyzed using descriptive statistics and the Kruskal-Wallis test, where appropriate.</p> <p>Survey - responses compared using Mann Whitney U test. Analysis conducted in STATA version 14.0</p>	<p>Data Usage: Over half the messages sent to resident physicians after implementation were read within one minute.</p> <p>Survey: Both physicians and nurses demonstrated statistically significant less disruptions to their workflows. Physicians felt they received more complete information over the messaging app.</p>	<p><b>Rating</b> Level III A/B (good/high quality)</p> <p><b>Worth to practice</b> Valuable information about clinician usage and perceptions of mobile devices and secure messaging apps.</p> <p><b>Feasibility</b> Strong implications in facilities seeking to implement secure messaging apps</p> <p><b>Strengths,</b> Usage data as well as end user perceptions were assessed/ described in complete detail with each element rated for its statistical significance</p> <p><b>Weaknesses,</b> Authors did not study content of messages (for urgency). Poor Wi-Fi connection post implementation may have affected survey results.</p> <p><b>Conclusions</b> The authors discussed the issue of sustainability, a factor they felt was assisted by the rising use of smartphones in non-work life.</p> <p><b>Recommendation</b> Enlarging the study to other areas of the hospital and determine if there were positive effects on patient outcomes.</p>

Purpose of Article or Review	Design/ Method	Sample/ Setting	Conceptual Framework	Major Variables Studied and their Definitions)	Measurement/ Data Analysis	Findings	Critical Appraisal Tool and Rating/ Worth to Practice/ Strengths and Weaknesses/ Recommendations
VanDusen, K. (2017). Calling on smartphones to enhance patient care, <i>Nursing</i> 2017.							
<p>This nursing article is a short summary of the advantages of smartphones in healthcare and a reminder of the pitfalls to avoid when implementing smartphone technology. There was no hypothesis or formal research associated with the article.</p>	<p>Expert opinion- no design or methodology</p>	<p>Not applicable</p>	<p>None noted</p>	<p><b>Independent Variable:</b> Not applicable</p> <p><b>Dependent Variable(s)</b> Not applicable</p>	<p>Expert opinion- no data analysis</p>	<p>The author highlights the benefits of smartphones including efficiency, effectiveness, improved emergency response time and increased frequency of provider responses to nurses. Pitfalls of this technology can be seen in the areas of confidentiality, destroying data, additional interruption that divides a clinician’s attention, and poor staff relations because of the technology.</p>	<p><b>Rating</b> Level V B (good quality)</p> <p><b>Worth to practice</b> Valuable short article specifically introduces the nurses voice to the discussion.</p> <p><b>Feasibility</b> Feasible as the opinion of an expert at the bedside</p> <p><b>Strengths,</b> Expert opinion from a frontline nurse, recommendations for future implementations from the frontline perspective. Strong references to support the authors opinion</p> <p><b>Weaknesses,</b> No actual study of interventions.</p> <p><b>Conclusion</b> Smartphone technology benefits clinicians in many areas but has multiple pitfalls.</p> <p><b>Recommendations:</b> Engage staff to reduce medical errors through improved communication and identification of issues. Ensure implementation teams provide adequate training that focuses on team building efforts and communication protocols.</p>

Purpose of Article or Review	Design/ Method	Sample/ Setting	Conceptual Framework	Major Variables Studied and their Definitions)	Measurement/ Data Analysis	Findings	Critical Appraisal Tool and Rating/ Worth to Practice/ Strengths and Weaknesses/ Recommendations
Whitlow, M., Drake, E., Tullman, D., Hoke, G., & Barth, D. (2014). Bringing technology to the bedside using smartphones to improve interprofessional communication. <i>CIN: Computers, Informatics, Nursing</i> , 32, No. 7, 305-311.							
To describe a quality improvement project where smartphone technology was implemented	<p><b>Design</b> Quality Improvement project</p> <p><b>Method</b> Survey and time and motion studies</p>	<p><b>Sample</b> 61 nurses and 44 physicians</p> <p><b>Setting</b> Nurses and Physicians in a med/surg unit in the University of Virginia Health System</p>	<p>The Donabedian Model on Patient Safety and</p> <p>The Delone and McLean Information Systems Success Model</p>	<p><b>Independent Variable:</b> the impact of using Smartphones at the bedside compared to pagers</p> <p><b>Dependent Variable(s)c</b></p> <ul style="list-style-type: none"> <li>- the quality of interprofessional communication</li> <li>- the response time between nurses and physicians</li> </ul>	<p><b>Measurement</b> Quantitative: differences assessed using Wilcoxon signed-rank test.</p> <p><b>Data Analysis</b> SPSS version 20 used for statistical analysis.</p>	The findings of the project were that smartphones demonstrated nurse and physician time savings, improved workflows, increased nurse-physician collaboration and allowed more time to be spent with the patient.	<p><b>Rating:</b> Level V-A Note: While there was statistically significant and robust analysis of quantitative data, the authors labeled this study as a Quality Improvement project. Therefore, its rating is Level V A under ‘Organizational Experience’</p> <p><b>Worth to practice</b> Valuable information on improvements mobile devices can bring to clinicians.</p> <p><b>Feasibility</b> Strong work in the form of both a time and motion study and a survey</p> <p><b>Strengths,</b> Robust analysis of both time and motion studies and survey responses. Statistically significant results</p> <p><b>Weaknesses,</b> Physician reluctance to participate fully may have had a negative effect</p> <p><b>Conclusion</b> Project demonstrated the feasibility and positive impact that smartphones have on communication response times.</p> <p><b>Recommendation</b> Further research on the impact of smartphone technology on patient satisfaction and safety and cost savings.</p>



## Appendix H

### Capabilities of a Fully Integrated CC&C Platform

Category	Functionality
Clinical Communication	<ul style="list-style-type: none"> <li>• Streamlined communication on a single mobile (hands-free or hand-held) device with a convergence of voice, secure messaging, video calls, and event management</li> <li>• Synchronous and asynchronous communication options</li> <li>• HIPAA compliance</li> <li>• Individual or group calls/messaging</li> <li>• Role-based clinical directory by department, team, or role (e.g., <i>“call ICU Respiratory Therapist”</i>)</li> <li>• Message read receipts</li> <li>• Staff location awareness</li> <li>• Push notifications (e.g., lab results)</li> </ul>
EMR and Patient Monitoring	<ul style="list-style-type: none"> <li>• Real-time mobile access to patient information</li> <li>• Flowsheet and notes documentation</li> <li>• Image capture</li> <li>• Barcode medication administration (BCMA)</li> </ul>
Clinical Efficiency	<ul style="list-style-type: none"> <li>• Clinical on-call schedules</li> <li>• Ability to see who is on duty in real time</li> <li>• Alarms for upcoming events</li> <li>• Share urgent information</li> </ul>
Alarm/Alert Management	<ul style="list-style-type: none"> <li>• View cardiac rhythms</li> <li>• Receive cardiac alarms stratified by event criticality</li> <li>• Intelligent alarms/alert escalation if no response received</li> <li>• Patient call/bed alarm notifications</li> </ul>
Workflow Efficiency	<ul style="list-style-type: none"> <li>• Mobility (prevents waiting for calls at a desk)</li> <li>• Transmission of administrative/urgent messages</li> <li>• Workplace rules/guidelines information</li> <li>• Handoff/ rounding tools</li> <li>• Faster staff response times</li> </ul>
Information Availability	<ul style="list-style-type: none"> <li>• Clinical practice, quality and safety guidelines access</li> <li>• View policies/procedures</li> <li>• View reference material e.g. Micromedex</li> <li>• Access to work email</li> </ul>

Adapted from Redelmeier and Detsky (2013), with permission (personal communication, September 2019)

**Appendix I**

**Gap Analysis**

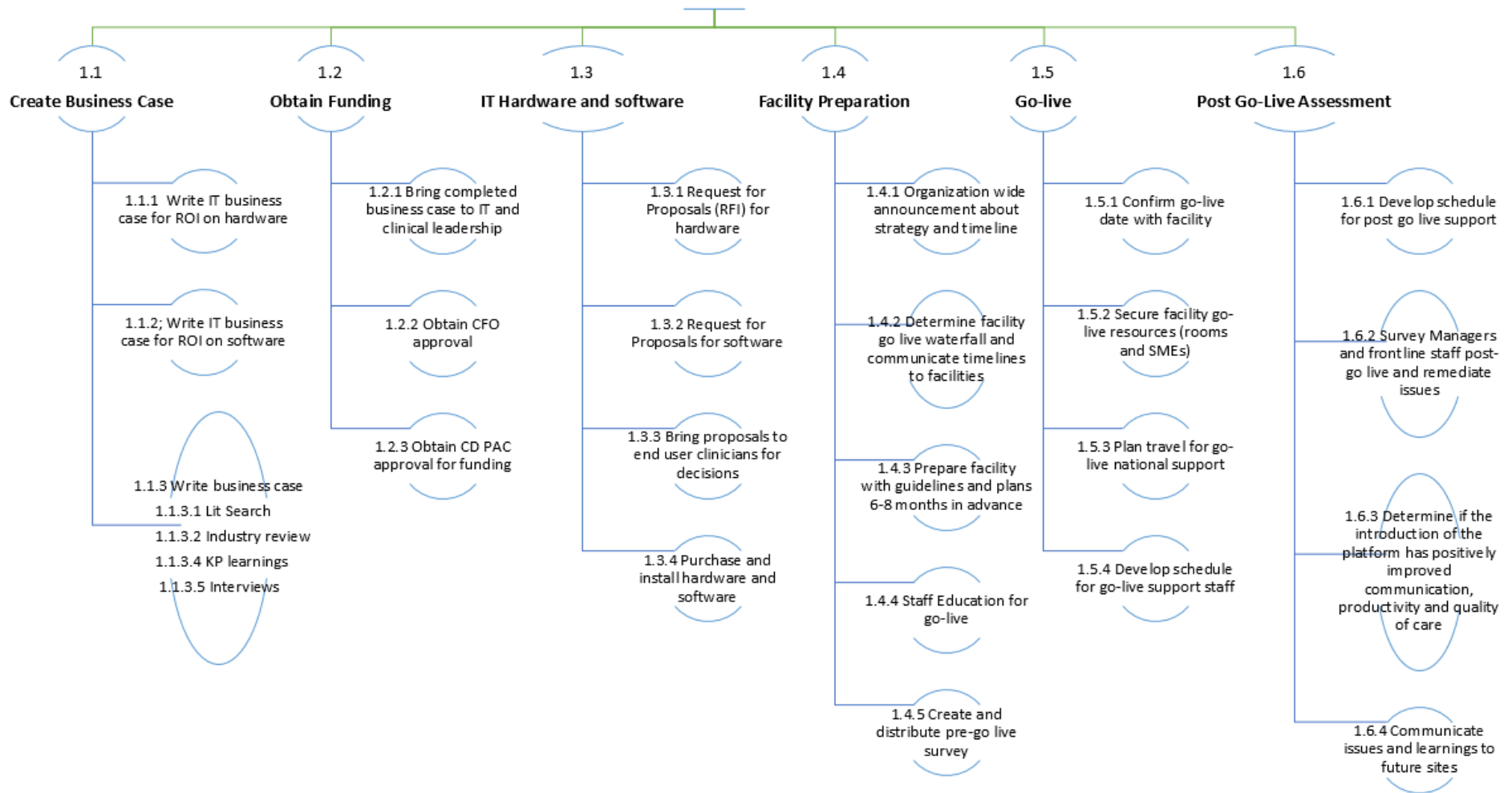
<b>Clinical Communication Focus Area</b>	<b>Current State</b>	<b>Desired Future State</b>	<b>Identified Gap</b>	<b>Action Plan</b>
<i>Focus area</i>	<i>Where are you now?</i>	<i>Where would you like to be?</i>	<i>Impact to the organization</i>	<i>Projects to undertake</i>
<b>Health System Level</b>	<p>Six of 39 hospitals with smartphone technology.</p> <p>33 of 39 hospitals still have older analog phones.</p> <p>Multiple different technologies requiring multiple departments to manage interoperability.</p>	<p>All facilities would be on the same clinical communication platform, which will improve quality, safety, clinician, and staff satisfaction, as well as financially assisting the organization to streamline technology into one product.</p>	<p>Multiple different ways to communicate between clinicians with resultant confusion, potential for organizational risk, and safety issues.</p> <p>Cost of maintaining multiple technologies.</p>	<p>Prepare an IT and clinical business case at the national KP level to determine the clinical and financial return on investment (ROI) for implementing a system like this.</p> <p>Collect data at the Southern California project site before and after go-live to inform the business case.</p>
<b>Facility Level</b>	<p>Physicians have iPhones and pagers and use Cortext for messaging with physicians.</p> <p>Nurses have Cisco phones.</p> <p>Pharmacy and ward clerks use desk phones to page physicians and to</p>	<p>All clinicians are on the same platform and communications are synchronous when needed (timely) and asynchronous when less urgent. There is no time wasted during clinical communication.</p>	<p>Patient safety and quality are risked by having poor communication methodologies.</p> <p>Reputation of the organization and ability to hire clinicians may be at risk from fragmented clinical communication.</p>	<p>Implement a unified clinical communication platform that is more efficient and streamlined for all clinicians and the care team.</p>

Clinical Communication Focus Area	Current State	Desired Future State	Identified Gap	Action Plan
	call nurses' Cisco phones.			
<b>Clinician Level</b>	<p>Multiple communication methodologies to collaborate, including paging, direct calling, waiting.</p> <p>There is frustration with poor communication when clinicians are not in the same location.</p>	<p>All clinicians are on the same platform, improving the quality of care.</p> <p>Collaboration improves.</p>	<p>Clinicians are using multiple communication methodologies, which wastes time and causes frustration, as well as risks quality and patient safety.</p>	<p>Implement a unified clinical communication platform that is more efficient and streamlined for all clinicians and the care team.</p>
<b>Implementation Gap</b>	<p>No formal <i>clinical</i> implementation guide to assist the facility in preparation for the go-live of the technology.</p>	<p>An implementation guide is developed to assist clinical facility leadership in preparation for future go-lives.</p>	<p>No implementation guide is in place to fully prepare the facility or clinicians for the future state.</p> <p>No clinical project lead is identified to champion the change.</p>	<p>Prepare an implementation guide for future go-lives and test that guide with currently live facilities.</p>

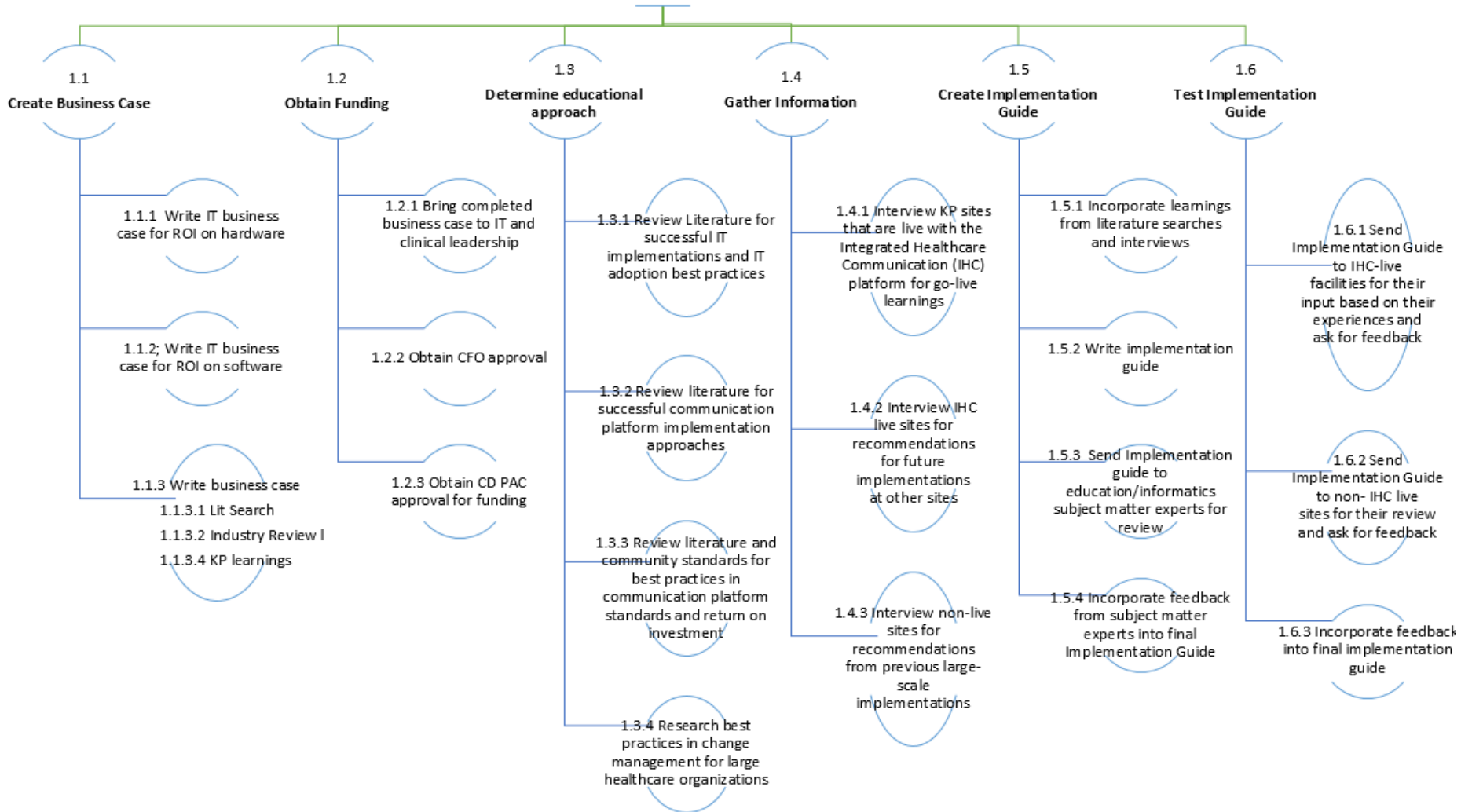


## Appendix K Work Breakdown Structure

L1: Implement a unified clinical communication platform in a multi-hospital system



**L1: Create an Implementation guide for a unified clinical communication platform in a multi-hospital system**



**Appendix L**

**SWOT Analysis**

Strengths, Weaknesses, Opportunities, Threats (SWOT) Analysis - Facility Level

	Helpful to Achieve the Objective	Harmful to Achieve the Objective
Internal Origin	<p><b>S</b>trengths</p> <ul style="list-style-type: none"> <li>- Strong facility leadership support for the implementation</li> <li>- Strong desire to improve clinical communication</li> <li>- Strong evidence to support platforms</li> <li>- Previous successes with these implementations within and outside Kaiser</li> <li>- Funding to do data collection</li> </ul>	<p><b>W</b>eaknesses</p> <ul style="list-style-type: none"> <li>- No policies or procedures in place to guide clinicians with the new communication methodologies</li> <li>- No implementation guide for the departments</li> <li>- Multiple other organizational priorities taking leadership time away from the go-live preparation</li> <li>- Each facility going live uses a different implementation methodology (no standardization)</li> </ul>
External Origin	<p><b>O</b>pportunities</p> <ul style="list-style-type: none"> <li>- Health system leadership support                             <ul style="list-style-type: none"> <li>o To unify the clinical communications amongst caregivers</li> <li>o To improve quality, safety, efficiency, clinician and staff satisfaction</li> </ul> </li> </ul>	<p><b>T</b>hreats</p> <ul style="list-style-type: none"> <li>- Technology problems pre-implementation</li> <li>- Lack of planning on the provider side for implementation</li> <li>- Lack of ongoing positions to maintain the application</li> </ul>

**Appendix M**  
**Budget**

		March	April	May	June	July	August	Sept	October	Nov	Total balance of expenditure
Total funding for 9 months:											
<b>Outgoing Expenses</b>	Project Lead Salary	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	
	Project Assistant Salary						2,500	2,500	2,500	2,500	
	Research Team						57,000				
	Travel							3,000		3,000	
	Facility Co-Leads							3,000		3,000	* Facility co-leads paid by facility
Monthly Balance Remaining		135,000	130,000	125,000	120,000	115,000	50,500	40,000	32,500	22,000	<b>+22,000</b>



## Appendix N

## Communication Plan

Communication	Frequency	Goal	Route
<b>Academic Advisors</b>			
Committee Chair	Weekly	Review project status, discuss barriers and updates, share progress	Email, zoom, phone calls
Co-Chair/Second Reader	As needed	To received feedback from draft prospectus	Email, zoom if necessary
<b>Project Sponsors (National IT and Nursing Leadership)</b>			
VP, Care Delivery Technology Services, National IT Executive Team	Twice a week	Review project from an IT perspective, strategize about barriers and facilitators, provide updates	Email and conference calls
Vice President, National Patient Care Services, Strategy and Operations, National Nursing Executive Team	Twice a week	Review project from a clinical perspective, strategize about barriers and facilitators, provide updates	Email and conference calls
<b>Site (Medical Center)</b>			
Chief Nurse Executive and Leadership Team, Medical Center	Once	Introduce the project plan and request participation	Phone conference
Medical Center Staff Nurses /leaders of shared governance councils/nurse managers	Once	Introduce the project plan and request participation	Face-to-face
Medical Center Hospital Based MD Staff (HBS) Leadership	Once	Introduce the project plan and request HBS participation	Face-to-face
Letter to participants and letter to leaders	Once		
Clinical Informatics Specialist, KP-MCX	Twice a week	Discuss project, request participants, coordinate pre and post implementation site visits	Phone conference
<b>Research Team</b>			
Primary Research Leader Adjunct Researcher	Twice a week	Discuss data collection methodology and analysis plan	Phone conference and face-to-face

## Appendix O

### Manager Letter of Participation

**To:** Clinical Leadership at [REDACTED] Medical Center.

**From:** National Facilities Services and the User Experience (UX) Research and Design Team

**Subject:** We are reaching out to select Clinical Leadership at [REDACTED] Medical Center to help us with an exciting opportunity!

With the upcoming Go-Live of Vocera technology and devices for staff, we are conducting a special effort to measure successes and opportunities for improvement of this new communications tool. This will be done through interviews, focus groups and shadowing. With this data collection effort, it will provide us the ability to quantify through careful data collection what is working and what is not working for [REDACTED] clinicians before and after the go live. Learnings will be shared with leadership, IT and others who have influence over technology and tool decisions for all our [REDACTED] staff throughout the Nation.

To conduct this effort, we are asking for your help in recruiting participants to work with our [REDACTED] Researchers. We are looking for staff who are most representative of the common “end-user” population.

- Participants will have the opportunity to have a one-on-one hour-long interview with a UX Researcher and/or attend a lunchtime Focus Group with peers and/or be shadowed for 3 hours by a UX Researcher
- All sessions will follow anonymous data collection practices, and feedback will not be associated back to any individual clinician
- Participation will not impact employment status or be a measure of individual staff member performance in any way
- Lunch will be provided at focus group sessions
- Shadowing activities will not impact care delivery
- Sessions will be conducted pre and post your go-live at the [REDACTED] Medical Center

Gathering insights directly from end users is critical to making sure the right technology is provided for clinical care delivery. For this reason, engagement with your staff is essential to the project’s success.

Please share names of individuals you believe would be a good fit for this activity and reach out if you have any questions.

Thank you in advance,

For questions, please email [michelle.m.machon@\[REDACTED\]](mailto:michelle.m.machon@[REDACTED]) or by phone at [REDACTED]

## Appendix P

### Staff Letter of Participation

Dear Staff at [REDACTED] Medical Center.

From: National IT Facilities Services and the End User (UX) Research and Design Team

Thank you for agreeing to participate in this exciting opportunity to work with us in collecting data on the usage of Vocera and its outcomes with effectiveness of communication amongst the healthcare team.

We are conducting a special effort to measure successes and opportunities for improvement of this new communication tool, through interviews, focus groups and shadowing. This will be an opportunity to quantify through careful data collection what is working and what is not working for [REDACTED] clinical staff such as yourself, before and after the go live. Learnings will be shared with Leadership, IT and others who have influence over technology decisions for all our [REDACTED] staff throughout the Nation.

To conduct this effort, we are asking you to volunteer and participate in any or all of the following formats:

- One-on-one 60-minute interviews with a UX Researcher and/or
- Lunchtime Focus Groups with peers and/or
- To be shadowed at work for 3 hours by a UX Researcher

#### **Please note**

- All sessions will follow **anonymous** data collection practices, **feedback will not be associated back to any individual clinician**
- Participation will not impact employment status at [REDACTED] or be a measure of individual staff member performance in any way
- Lunch will be provided at focus group sessions
- Shadowing activities will not impact care delivery
- Sessions will be conducted pre and post go-live at the [REDACTED] Medical Center.

Gathering insights directly from clinicians like yourself is critical in making sure the right technology is provided for the delivery of care at our facilities. For this reason, engagement with clinical end-users is essential to project success.

Please work with the project coordinators to sign up for a session time that fits your schedule and we will send a calendar invite and details shortly. Feel free to reach out if you have any questions to [michelle.m.machon@\[REDACTED\]](mailto:michelle.m.machon@[REDACTED])

**Appendix Q**

**Cost/Benefit Analysis**

**Cost Avoidance Estimates from IECCS Soft to Hard Dollar Summary**

**Based on Local Variable Cost Only Data**

<b>1. Hospital Throughput Improvement</b>	2019 Annual M/S/T Discharges	13,404
Based on Avera Health reduction in discharge time by 22 minutes	Saved Time per Discharge (Hours)	0.37
	Total Time Saved (Hours)	4,914.80
	RN Hourly Wage (5% OT)	\$98.70
	M/S/T RN Nursing Ratio (1:4/1:5)	0.222
	Break/Lunch Burden	13%
	Non-Prod Burden	24%
	T&B Burden (KFH)	42.80%
	<b>RN Variable Cost/Hour</b>	<b>\$43.89</b>
	<b>Total Annual Savings</b>	<b>\$215,694 at Facility R</b>

<b>2. Improve OR Efficiency</b>	2019 ROS/FOL Surgical Cases	19,500
Based on Major Health Partners - 5 minutes saved per case	Saved Time per Case (Hours)	0.08
	Total Time Saved (Hours)	1,625.00
	RN Hourly Wage (5% OT)	\$98.70
	Scrub Tech Wage (5% OT)	\$49.35
	In-room RN staff as % of RN/Scrub	55%
	Combined in-room hourly wage	\$152.99
	Break/Lunch Burden	13%
	Non-Prod Burden	24%
	T&B Burden (KFH)	42.80%
	<b>In-Room RM/Tech Cost/Hour</b>	<b>\$306.11</b>
	<b>Total Annual Savings</b>	<b>\$497,428 at facility R</b>

(\$ millions)	
Benefit Description	Total Value* (2022-2026)
Hospital Throughput Improvement	\$20.75
Improve OR Efficiency	\$47.85
<b>Soft Benefits Sub-Total</b>	<b>\$68.60</b>
<b>Grand Total Benefits</b>	<b>\$68.60</b>

Note: \$ 68.6 million dollar benefit relates to Grand Total Benefits multiplied by the 39 hospitals in the health system.

**Appendix R**

**Fieldwork Guides**

<p>IHC Shadowing Data Sheet</p>	<p>Participant # _____ Researcher _____                  Participant Role: _____                  Date: ____/____/____                  Start Time: _____</p>
ACTIVITY/TIMING	NOTES & OBSERVATIONS
<p>Time/Experience to Contact Provider                  Time/Experience to Contact Team Member                  Time/Experience to Contact Help                  Time/Experience to Discharge Patient                  Other:</p>	<p>Purpose:                   Location Changes:</p>
<p><b>TIMING DATA: (Capture Start and End Times, if activities occur between Start and End, capture and event could include time to receive reply, for example)</b></p> <p>START:                   EVENT:                   EVENT:                   EVENT:                   EVENT:                   END:</p>	<p>Devices Used:                   Pain Points/Delays:                   What Signified end of Task:</p>
<p>Time/Experience to Contact Provider                  Time/Experience to Contact Team Member                  Time/Experience to Contact Help                  Time/Experience to Discharge Patient                  Other:</p>	<p>Purpose:                   Location Changes:</p>
<p><b>TIMING DATA: (Capture Start and End Times, if activities occur between Start and End, capture and event could include time to receive reply, for example)</b></p> <p>START:                   EVENT:                   EVENT:</p>	<p>Devices Used:                   Pain Points/Delays:                   What Signified end of Task:</p>

# IHC (Integrated Hospital Communications) Focus Group Guide 09.16.19

Date	Time	Provider	Provider Role / Specialty / Location

**Methodology**

**Method:** 60-minute focus groups with 5-7 Care Delivery Staff in person and recorded.

**Participants** KP-MCX Care Delivery Staff

**Assumptions, Requirements, Dependencies:** Access to care delivery staff. Regional assistance to identify staff. Access to location to hold focus group.

**Goals**

The IHC focus group is to understand what is working well or not so well for communications, so we can identify any insights, pain points and/or barriers to communications for the present state.

**Provider Consent Forms**

Consent Form: <https://www.surveymonkey.com/r/SHD7CZ2>

Release Form: <https://www.surveymonkey.com/r/SHC5FQ3>

**Focus Group Checklist**

- KP iPhones to record (2)
- Computer to display deck
- Projector
- iPad for consent forms
- Badge Clips/Thank You
- Antibacterial wipes (1)
- Mac projector cable

**Facilitator 1 Duties**

- Provide introduction
- Present Slides and provide talking points
- Ask primary questions
- Ask secondary/probing questions as needed

- Provide closing remarks

**Facilitator 2 Duties**

- Clean and prep food serving areas as needed
- Make sure food is set up and easy to access
- Arrange room in a way that facilitates conversation
- Take notes during discussion
- Ask secondary/probing questions as needed
- Pass out thank you cards as providers exit

## IHC Focus Group Guide

---

### Welcome and Introduction (5 min)

Thank you for coming! My name is [ ]. I'm a User Experience Researcher, on the User Experience group at Kaiser Permanente. I am here with my colleagues [ ], other User Experience Researchers, who will be taking notes. The purpose of this focus group is to help us understand your experience with clinical communications here at KP-MCX what is working well or not so well with the tools you use for communications, so we can identify any insights, pain points and/or barriers in communication workflows.

We are not familiar with all the processes for your specific communications, so some of the questions we will ask you might involve you walking us through some of these processes. This focus group should take about 60 minutes. Should the conversation run a few minutes later, anyone with a hard stop is encouraged to depart when they need to.

Anything we discuss or you share today is confidential and will only be used to help the UX team work on improving the communications experience for care delivery staff like you. Your name will not be associated with any information that you provide. We are recording today's session in order to capture all of your insights. Our recordings are password protected and will be kept in a secure file and location.

We encourage you to freely provide your honest input today so that we can better understand things that work and don't work for you. This is not a test, and there are no wrong answers, just differing points of view. The sole purpose of today's meeting is to evaluate communication systems. Feel free to discuss your opinion even if it varies from what others have said. Negative comments are just as appreciated as positive, and can often be the most helpful in terms of assessing the application.

There are iPads floating around with a consent form and a release form. Please sign these before you leave. Any of us can help you or answer any questions related to these forms. They are standard practice for our team any time we engage with KP end users like you.

Are there any questions before we get started?

Great, let's begin.

I'm going to start the recording, okay?

[start recording]



### Discussion with Participants

---

#### *General (3 minutes)*

We would like to get to know a little more about you. Let's start with quick around the room to hear what your role is here at KP.

#### *Understanding Workflows (10 min)*

First we would like to hear a little bit about communications you need to do to provide care.

Do you mind sharing one of your most common communications workflows? Who do you communicate with? What defines a successful communication for you for this scenario? We are not interested in how you complete these communication workflows, but rather who and what you need to communicate.

(repeat this ask until all the common workflows are defined)

Who they communicate with?

What the objective is of the communication?

#### *Understanding Devices and Tools (5 min)*

Great, so now let's talk a little about the tool you use for care delivery communications.

What devices do you use? What software or tools do you use?

Think back to the workflows you shared, have you mentioned all of the tools you use to complete these tasks?

#### *Understanding Devices and Tools (10 min)*

So, what is working/what is not working when you perform these communications workflows with the tools you are provided?

Make sure they touch on pain points with the workflows and with the devices/tools

#### *Impact to Patient Satisfaction (10 min)*

How do the pain points you described impact Patient Satisfaction? Can you share examples?

*How would you? (5 min)*

Reference the pain points, ask them how they would address those pain points. What are their ideas for improvement?

*Follow -Up Questions (As Needed)*

- Can you tell me more about that?
- Can you tell me in what context that would occur?
- Can you tell me more about that workflow?
- What is your objective during that process?
- Is this an issue during a patient encounter?
- How would you handle the issue in an office visit?

*Bringing the Discussion Back (As Needed)*

- Thanks for sharing your perspective. Going back to [theme].
- I can see why that would be frustrating/annoying/etc. We will add this finding to our notes. Let's discuss a little more about [theme].

*Closing Remarks (2 minutes)*

- Thank you very much for taking the time to participate today. Your responses and feedback are very valuable and helpful. Have a great rest of your day!

### IHC Interview Guide

Date:

Role:

1. What is your role?
2. What is your age? (optional)
3. What are the most common communications you need to do to provide care? (who, end goal) What tools do you use for care delivery related communications (hardware & software)?
5. Do the devices you described require maintenance? If so, ask the user to share details |
6. Are these devices reliable? If not, ask the user to share details. How do these tools support you with care delivery communications? (usefulness)
8. How did you learn how to use this technology? (probe if training was sufficient) (learnability) What are the biggest challenges you face with communications you need to do your job? (ease of use/efficiency/usefulness/quality)
10. How do the tools provided aide you with communications you need to do to do your job? (ease of use/efficiency/usefulness/quality)
11. From your experience, how do the tools you use for communications support or not support perceived member and caregiver satisfaction?
12. From your experience, how do the tools you use for communications support quality and safety

Now I am going to read you a few statements to summarize what you have shared.

Rate each statement on a scale of 1 to 10, 10 being highest.

- The communications tools I am provided support efficient and effective care delivery communications.
- The communications tools I am provided support patient/caregiver satisfaction.
- The communications tools I am provided are reliable.
- The communications tools I am provided are maintenance free.
- The communications tools I am provided are efficient.
- The communications tools I am provided result in efficient turnaround times.
- The communications tools I am provided support quality communications.
- The communications tools I am provided support care team engagement.
- The communications tools I am provided support patient safety.

**What if...**

**Appendix S**

**Index of Topics from Implementation Guide**

Kaiser Permanente

Integrated Enterprise Clinical Communication Strategy (IECCS)

Clinical Communication

Step by Step Implementation Guide

for Facility Leads

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VERSION 1.4

8/27/2020



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## Appendix T

### Implementation Guide Online Survey

#### IECCS "Implementation Guide" Feedback

\* please note, the terms IHC (Integrated Healthcare Communications) and IECCS (the new name for the program- Integrated Enterprise Clinical Communication Strategy) are used interchangeably in this survey)

1. Is your Facility/Region

- Already live with IHC/IECCS?
- Planning to go live with IHC/IECCS in the future?
- Other (please specify)

2. This Implementation Guide provides all the details I need as a nurse leader responsible for an IECCS implementation.

- Strongly Agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly Disagree

Please detail any items you might feel are missing?

3. This guide would have assisted me during my facility's s implementation of IHC/Vocera.

- Strongly agree
- Disagree
- Agree
- Strongly disagree
- Neither agree nor disagree
- Not Applicable

4. This guide will be a useful resource for facilities going live with IECCS in the future.

- Strongly agree
- Disagree
- Agree
- Strongly disagree
- Neither agree nor disagree

Comments:

5. I foresee there will be challenges using this guide.

- Strongly agree
- Disagree
- Agree
- Strongly disagree
- Neither agree nor disagree

What challenges might you foresee using this guide?

6. Please add any comments (in as much detail as possible) you may have about this Implementation Guide?

## Appendix U

## Project PDSA Cycle





**Appendix V**

**Letter of Non-Research Determination**

**InterOffice Memorandum**

Organization Logo

8/7/2019

**To: Michelle Machon, MSN**  
Practice and Informatics

**Re: "Collection of pre and post Vocera Implementation Data at Medical Center"**

Dear Ms. Machon,

A designated reviewer on the (KPSC) Institutional Review Board (IRB) reviewed your submission and determined that this is not human subjects research as defined by 45 CFR 46.102 (e)(1) and (l). Therefore, IRB review of this project is not necessary.

Sincerely,



---

Armida Ayala, MHA, PhD  
Director of Human Research Subjects Protection  
Office/Institutional Review Board (IRB)

**Appendix W**

**Letter of Organizational Permission**

**Organization X**

Sept 9, 2019

School of Nursing,  
University of San Francisco

To whom it may concern,

Please accept this letter as my support and approval for Michelle Marie Machon to implement her Doctor of Nursing Practice Comprehensive Project at Michelle's project is to collect data pre and post implementation of the Vocera communication system at the ~~KP-MC~~ Medical Center in Southern California. She has received a determination by the \_\_\_\_\_ (California Institutional Review Board (IRB) that this project is not human subjects research and therefore IRB review of this project is not necessary.

This letter also verifies that \_\_\_\_\_ has an existing contract with the University of San Francisco's School of Nursing.

Thank you,



\_\_\_\_\_, DNP, MSHCA, RN, CENP  
Vice President, Strategy and Operations  
National Patient Care Services

## Appendix X

### DNP Statement of Non-Research Determination



#### DNP Statement of Non-Research Determination Form

**Student Name:** Michelle Machon

**Title of Project:**

Effects of implementing a unified clinical communication platform in a hospital setting

**Brief Description of Project:**

**A) Aim Statement:**

The aim of this project is to determine the effectiveness of the implementation of a unified clinical communication platform in an acute care hospital setting.

**B) Description of Intervention:**

1. the intervention will replace old technology (Cisco/spectralink) phones for nurses with a smart device that has voice, alerts/alarms and the Vocera Collaboration Suite (VCS) and will add the VCS App to the MD iPhones.

2. VCS will provide:

- o Voice
- o Instant messaging
- o Clinical directory with ability to see who is in the hospital at any given time
- o Group messaging
- o Role based calling and messaging (e.g. "call hospitalist on duty" or "call ICU Respiratory Therapist")
- o Alert and alarm delivery
- o On-call directory

**C) How will this intervention change practice?**

It is the expectation that the technology will improve communication between clinicians. Other hospitals that have implemented this platform have reported improvements in communication, efficiency, patient and staff satisfaction.

**D) Outcome measurements:**

Outcomes will be measured through:

1. Interviews

- In depth interviews about current communication methodology strengths, weaknesses and opportunities (pre and post implementation)

- Plan for approx. 4 participants from each group (RN, MD, Pharmacy, UAs)
- Communication to be sent to all staff: they would be asked to volunteer and would be informed that no names would be associated with the data, it would be voluntary, no personal identifiers would be recorded and none of the information or content would be reported to management etc.)
- 2. Observations /time and motion
  - Following the same types of participants above, we would observe staff in their normal day to day work (unchanged standard of care) to determine the amount of time they spend in a given shift on communication
  - Target observations examples include
    - o Time spent reaching out to Provider
    - o Time waiting for response
    - o Interdepartmental communication time
    - o Time spent communicating about transferring patients
    - o Time spent by UA finding RN or other team members
    - o Time spent communicating during emergencies
- 3. Data collection from information/metrics already available. Some examples include:
  - Number of overhead pages
  - ED to inpatient admission time
  - Nurse satisfaction (e.g. satisfaction with technology)
  - Patient satisfaction (e.g. quiet at night)
  - Number of calls made/messages sent
- 4. An online survey
  - A survey about the communication practices at Downey would be administered to all patient care services staff, seeking staffs perceived satisfaction with the pre and post implementation methodologies. Survey would be sent to all staff listed above via survey monkey and staff would be informed their response would be anonymous with no personal identifiers captured.
- 5. Focus Groups
  - Take a piece of information and see how it flows through the care team
  - focus group to get a discussion going with all entities in the room – using a flow diagram/process mapping using lean methodology to capture the data.

To qualify as an Evidence-based Change in Practice Project, rather than a Research Project, the criteria outlined in federal guidelines will be used:  
<http://answers.hhs.gov/ohrp/categories/1569>

This project meets the guidelines for an Evidence-based Change in Practice Project as outlined in the Project Checklist (attached). Student may proceed with implementation.

This project involves research with human subjects and must be submitted for IRB approval before project activity can commence.

Comments:

**EVIDENCE-BASED CHANGE OF PRACTICE PROJECT CHECKLIST \***

Instructions: Answer YES or NO to each of the following statements:

Project Title:	YES	NO
The aim of the project is to improve the process or delivery of care with established/ accepted standards, or to implement evidence-based change. There is no intention of using the data for research purposes.	X	
The specific aim is to improve performance on a specific service or program and is a part of usual care. ALL participants will receive standard of care.	X	
The project is NOT designed to follow a research design, e.g., hypothesis testing or group comparison, randomization, control groups, prospective comparison groups, cross-sectional, case control). The project does NOT follow a protocol that overrides clinical decision-making.	X	
The project involves implementation of established and tested quality standards and/or systematic monitoring, assessment or evaluation of the organization to ensure that existing quality standards are being met. The project does NOT develop paradigms or untested methods or new untested standards.	X	

The project involves implementation of care practices and interventions that are consensus-based or evidence-based. The project does <b>NOT</b> seek to test an intervention that is beyond current science and experience.	X	
The project is conducted by staff where the project will take place and involves staff who are working at an agency that has an agreement with USF SONHP.	X	
The project has <b>NO</b> funding from federal agencies or research-focused organizations and is not receiving funding for implementation research.	X	
The agency or clinical practice unit agrees that this is a project that will be implemented to improve the process or delivery of care, i.e., <b>not</b> a personal research project that is dependent upon the voluntary participation of colleagues, students and/or patients.	X	
If there is an intent to, or possibility of publishing your work, you and supervising faculty and the agency oversight committee are comfortable with the following statement in your methods section: <i>"This project was undertaken as an Evidence-based change of practice project at X hospital or agency and as such was not formally supervised by the Institutional Review Board."</i>	X	

**ANSWER KEY:** If the answer to **ALL** of these items is yes, the project can be considered an Evidence-based activity that does **NOT** meet the definition of research. **IRB review is not required. Keep a copy of this checklist in your files.** If the answer to **ANY** of these questions is **NO**, you must submit for IRB approval.

\*Adapted with permission of Elizabeth L. Hohmann, MD, Director and Chair, Partners Human Research Committee, Partners Health System, Boston, MA.

**STUDENT NAME (Please print):** MICHELLE MACHON

**Signature of Student:** Michelle Machon **DATE:** August 7<sup>th</sup> 2019

**SUPERVISING FACULTY MEMBER (CHAIR) NAME (Please print):**  
Mary Lynne Knighten, DNP, RN, NEA-BC

**Signature of Supervising Faculty Member (Chair):** Dr. Mary Lynne Knighten **DATE:** October 14, 2019

**Appendix Y**

**Qualitative Data Collection: Verbatim Interview Responses**

	<b>Pre-Implementation</b>	<b>Post-Implementation</b>
<b>Interviews</b>	<p>Before implementation, staff said their analog phones “are not perfect, but they work” and were “pretty much self-explanatory” with little training needed. However, they reported that they broke easily, had static during calls, frequently turned off for no reason, and staff stated it’s “challenging if I can’t get a hold of a doctor right away.” Staff had developed many workarounds for when the analog phones did not work. Finally, they said the challenge with the current system was “to know how to contact physicians: some want calls, some don’t, a process for escalation is not defined.” When asked what they wanted from a new communication system, they stated they wanted a modern, single, reliable device (like their home phones) with better connectivity, better alarm management, and a way to know the priority of communication workflows.</p>	<p>Staff stated that “in the beginning it was chaos,” but then said that there was “improvement over time.” Other positive comments included the longer battery life, the benefits of mobility, and the texting capabilities. Part of the technology implemented was the ability to send secure messages to the care team, and this was probably the most well received functionality by staff, as was the ability to do role-based calling and “not having to memorize phones numbers anymore.” For the messaging application, staff “like that you can see the roles, you can look up a role like ED Room 5 Nurse.” However, the negative comments outweighed the positives on interview, with themes including frustration, chaos, and unreliability. One participant stated, “It’s still not running smooth, we’ve had what, a month, and it’s still very frustrating.” The Wi-Fi connectivity was a repeated theme in the interviews, and one nurse reported, “A physician may be signed in, but may be in a dead space</p>

	Pre-Implementation	Post-Implementation
		<p>in the hospital and we can't get ahold of them," while another staff member said, "There are so many problems with connections, this impacts consumer satisfaction."</p> <p>There were such issues with connectivity that one whole department reverted to back to analog phones for eight months post go-live because of unreliable Wi-Fi.</p> <p>Because the device relies on Wi-Fi, voice recognition was a significant issue for staff, "I feel like a dummy repeating and repeating." They also stated the nomenclature for calling was not intuitive and that words need to be phrased correctly. They reported there was no guidance and clinicians had to "figure it out by trial and error." From a user-interface perspective, staff felt the TC51 was heavy, the keyboard was not intuitive, and it had a poor user interface (UI). While the role-based and group-calling features were appreciated, staff were surprised that they "can no longer just simply dial an extension." Training was another theme that the interviewees identified as a challenge. Some key stakeholders were left in the dark about the Vocera roll-out (for example the Operators), training was "generally</p>

	Pre-Implementation	Post-Implementation
		<p>insufficient and not attended by all users,” and there were training gaps, where again, some nurses felt they had to “figure it out” on their own. Operationally, staff stated that others were not signing themselves in properly; therefore, you could not get ahold of them, and while most operational workflows remained the same for users, some staff were never converted off the analog phones, and this was confusing for clinicians. A final theme identified was end-user go-live support, which staff felt was lacking: “My understanding was that there was going to be people on the floor for a week. Any questions, we would see them, call them, or get their attention, whatever, and they would help us... but there was nobody. Basically, I felt like here’s the phone, done.”</p>
<p><b>Focus Groups</b></p>	<p>In the pre-implementation focus groups, nursing staff said they had frustrations with the analog phones as “not all staff have them” and more importantly, “when we need a physician quickly, we send them multiple messages and sometimes they can’t get through to them at all.” They also were disturbed with the older</p>	<p>Staff had both positive and negative elements to report post-implementation. The ability to send secure “text” messages after implementation was the number one benefit reported by nurses, and they even reported, “It holds people a little bit more direct-accountable: I sent you a text at this time.” Yet, nurses in the focus groups</p>



	Pre-Implementation	Post-Implementation
	<p>functionality: batteries that did not last a whole shift, phones that shut off for no reason, and a speaker setting that was loud enough to disturb patients. The feedback from the ward clerk, physician, and pharmacist pre-implementation focus groups were similar. One ward clerk stated: “It is hard for us to find a nurse if they don't have a phone because we have to check each room they are assigned to.” A pharmacist said: “If paging doesn't work, then Skype, then the operator, then Cortext, then call – we have to use multiple methods before getting through.” One physician stated: “We need one system so we don't have to carry multiple devices.”</p>	<p>also reported the call-quality and voice recognition as poor, alarm fatigue was not ameliorated, and while they reported the issues in Labor and Delivery where they went back to the analog phones due to the connectivity issues, they also said some departments were carrying the new devices <i>and</i> the old analog phones due to reliability concerns. While the other focus groups reported benefits, like the ability to see who called you, the secure messaging, and not having to go through the operator or ward clerk, the issues of staff not signing into Vocera, the confusion over not having numbers, sub-adequate training, and the poor reception were still concerns. The physician focus group also noted that “only 10-20% of users are properly logged in,” as well as the unhappy surprise that anyone could call them directly, and they had no ability to “triage” calls like they previously did with pagers.</p>
<b>Observations</b>	<p>Pre-implementation shadowing demonstrated the manual workflows that staff had put in place to communicate, including writing their extension on visual boards at the nurses' station and physicians walking by that board to</p>	<p>Post-implementation shadowing echoed the positive findings of the interviews and focus groups, including the value of secure messaging, the ability to take pictures, and to broadcast messages to groups of staff. End-users</p>

	Pre-Implementation	Post-Implementation
	<p>see the numbers. The data obtained included observing the challenges of the older broken analog phones and the noise level of the emergency department. The need for the triaging of calls through the ward clerk was noted, as well as the subsequent chaotic environment when no ward clerk was on duty.</p>	<p>reported other benefits, like the ability to set and call from a favorites list, and that “Vocera allows for more organized communication.” However, the negatives were evident in the shadowing experiences, including “contact method overload,” meaning the negative side of the number of ways staff now had to contact each other. Confusion over who was on Vocera versus still on analog phones, frustration with voice recognition, usability issues with no phone numbers to dial, and training problems were all noted during direct observations.</p>
<b>Surveys</b>	<p>Pre-implementation one physician expressed their trepidation for using Vocera at KP-MCX, stating they had used it at other facilities, and it was “faulty and unreliable.” Other clinicians stated they simply wanted one device and something more “versatile” than the “outdated” analog phones.</p>	<p>Post-implementation survey comments were overwhelmingly negative and were found to correlate to the following themes: poor connectivity, poor quality calls, a poor rollout, inadequacies in training, and difficulties using the badge <i>genie</i>. The form factor of the device was the subject of multiple comments, including the size, weight, multiple steps to make a call, the login, and difficulties with the user interface.</p>