2016

Assessing Post Operative Information Transfers: Evaluation of Patient Outcomes

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Evaluation of Patient Outcomes

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A dissertation submitted to the faculty of the
Medical University of South Carolina in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy in the College of Nursing.

November 17, 2016

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Acknowledgements

'To God be the glory, great things he hath done'

I dedicate this compendium to my mother, Ethel Delores McGrier Rose and Marlyne Little McKee. My mother and godmother, respectively, are at peace and eternal rest in their father's house. I especially appreciate the kind words of encouragement from W L Rose (i.e. Dad), Marc Rose, big brother, Carmen Wynn (aunt), Gail Copeland, Joyce "JAM", and my cohort partner in crime Kim Pickett.

The work behind this dissertation compendium could not have been completed without the skilled help and support of a wonderful group of faculty at Medical University of South Carolina, College of Nursing. Honestly, there are too many faculty members to acknowledge. Having said this, the first grand acknowledgement to the entire faculty who has offered their feedback and instruction over the past three and one half years. My committee was skillfully led by Susan Newman, PhD, and there are no words to express my gratitude and appreciation for her continued support, pats on the back, and gentle nudges when I was doubtful. I am eternally grateful for Dr. Newman. To Drs. Martina Mueller and Gayenell Magwood, you are superstars as well. Your support and direction were key to keeping me on track. Our content expert, Dr. Courtney Brown, was exceptional. Dr. Brown was excited to see the progress of our research and what a pleasure it was to hang out with her at the AANA national assembly. Not only did I have a top-notch committee, I truly believe I have gained three new friends who happen to be experts and seasoned researchers. I'm thankful for this opportunity.

Let us not forget the great wordsmith, Thomas Smith, PhD, center of academic excellence. Also, a special thanks to Mohan Madisetti, program manager, College of Nursing for all his help with developing the instrument for this study. There was a balancing act between working full time and completing this work, many, many thanks to Eileen Begin, MD and the department of Anesthesiology at MedStar Washington Hospital Center for their support and understanding. The dissertation compendium was masterfully put together by Mrs. Yolanda Long, "Girl, thank you; Love you much". Last and certainly not least, it was a pleasure to work with Ron Miques, MD and the Medstar Health Research Institute who helped manage funds awarded through the AANA Doctoral Fellowship and the AORN/CCI grant.

Everyone IS a shining star!

Abstract

Purpose: The purpose of this dissertation research was to study postoperative handover information transfers (PITS) and to ultimately improve patient safety and patient outcomes. One of the goals was to identify deficits in PITS by exploring information needs and processes related to PITS. Grounded by the social ecological model (SEM), a scoping review of extant literature was conducted to identify individual, interpersonal, organizational environmental and organizational policy level factors that influence the quality and processes of post-operative information transfers (PITS). An integrative review of extant literature was conducted to describe how PITS have been studied and to describe instruments that have been developed to improve PITS. Using participatory action research, a sequential mixed-methods study was undertaken to assess the feasibility of and pilot test the electronic post-operative information transfer instrument (EPITI).

Problem: PITS have been described as fraught with errors and prone to information omissions (Catchpole, Sellers, Goldman, McCulloch, & Hignett, 2010; Segall et al., 2012, 2012). Information transfers between anesthesia providers and post anesthesia care unit nurses take place among a myriad of other patient care activities including re-establishing monitoring technology while communicating the verbal report (Smith, Pope, Goodwin, & Mort, 2008). Deficits in PITS have been associated with delays in medical treatment, and increased morbidity and mortality (Nagpal et al., 2013; Rose & Newman, 2016; van der Walt & Joubern, 2014). Previous research has shown that standardization of PITS increases the amount of information transferred (Potestio, Mottla, Kelley, & DeGroot, 2015; Salzwedel et al., 2013; Siddiqui et al., 2012) One way PITS have been standardized is by including post-operative information transfer forms within anesthesia information management systems (AIMS). Research is needed to assess the feasibility of implementing AIMS, including the EPITI by gaining insight from key stakeholders, defined as anesthesia providers (AP) and PACU nurses. Additional research is needed that describes the development, implementation and evaluation of electronic PIT instruments.

The purposes of the manuscripts included in this dissertation were:

Manuscript I Scoping Review: To identify factors at each level of the Social Ecological Model that influence PITS

Manuscript II Integrative Review: To describe and synthesize instruments

developed to improve PITS and to describe how PITS have been studied

Manuscript III Pilot and Feasibility Study: To report on pilot testing and evaluation of the feasibility of the electronic post-operative information transfer instrument (EPITI)

Design: Sequential mixed methods using a participatory action approach

Findings: Individual, interpersonal, organizational and environmental factors influence PITS. Efforts including standardization of PITS have been undertaken to decrease information omissions and to improve interpersonal communication. After pilot testing the EPITI, results of qualitative and quantitative data analysis showed the EPITI was feasible, acceptable and integrated well into clinical practice when pilot tested by AP and PACU nurses.

Conclusion: Additional research is needed to implement and assess the effect of electronic postoperative handover instruments on patient specific outcomes.

Key words: *postoperative, handovers, instruments, feasibility*

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Introduction

In 2001, The Institute of Medicine (IOM) issued the pivotal statement that inadequate patient handovers are “where safety often fails first.”(Institute of Medicine (US) Committee on Quality of Healthcare in America, 2001) Following this statement, the Joint Commission’s “2006 National Patient Safety Goals” initiated the patient safety standard that all health care providers implement a standardized approach to postoperative handovers, the transfer of patients from the operating room to postoperative care (Patterson & Wears, 2010). Furthermore, the Joint Commission estimated that communication errors during patient handovers account for 80% of medical errors (Joint Commission, 2012). Failure to transfer critical pieces of information are associated with delays and errors in treatments, increased length of stay, and, potentially, increased morbidity and mortality (Nagpal et al., 2013). Because of numerous transition points in care, surgical patients are particularly vulnerable to communication errors (Nagpal et al., 2011). Moreover, communication senders (APs) and receivers (PACU nurses) have different information needs and expectations of processes, including the timing, during post-operative information transfers (PITS) (Robins & Feng Dai, 2015). Coordinated communication among providers is necessary to facilitate safe postoperative information transfers (PITS) and prevent adverse patient outcomes (Robins & Feng Dai, 2015).

Background

Qualitative and quantitative studies have been conducted to improve the quality and processes related to PITS. To address communication deficits in PITS, previous research used focus groups with AP, PACU nurses, and surgical teams to identify gaps in information transfers, including information omissions, and to gain consensus related to necessary information content during PITS (Nagpal, Arora, et al., 2010; Nagpal, Vats, Ahmed, Vincent, & Moorthy, 2010; Nestel, Kneebone, & Barnet, 2005; Smith & Mishra, 2010; Smith, Pope, Goodwin, & Mort, 2008). Likewise, qualitative research has been conducted to elucidate clinical information needs of APs when developing an HER (Herasevich, Ellsworth, Hebl, Brown, & Pickering, 2014). Observational studies have evaluated information transfers across the surgical pathway and described how anesthetists hand patients over to PACU nurses (Nagpal, Vats, et al., 2010; Siddiqui et al., 2012; Smith et al., 2008). Several studies focused on delineation of provider information needs and development of standardized protocols for PITS (Breuer, Taicher, Turner, Cheifetz, & Rehder, 2015; Lane-Fall et al., 2014; Mistry et al., 2008; Petrovic et al., 2012).

One way to improve communication among providers and facilitate effective PITS is to utilize electronic health records (EHRs) (Van Eaton, Horvath, Lober, Rossini, & Pellegrini, 2005). As the transition to EHRs proceeds and gains momentum, health care systems are integrating anesthesia information management systems (AIMS) to facilitate peri-operative patient transitions.

Potential advantages of implementing AIMS include improved patient safety, quality of care, and enhanced exchange of complex health information (Stabile & Cooper, 2013). One study aimed to create a more efficient EHR viewer by surveying APs to determine their intraoperative and PACU needs (Herasevich et al., 2014). However, extant literature is lacking studies that describe integration of AP and PACU nurse identified PIT processes into implementing electronic PIT forms. Moreover, research is needed to assess the feasibility of implementing AIMS, including electronic PIT forms, by gaining insight from key stakeholders, defined as AP and PACU nurses. This research specifically addressed this gap by providing an opportunity for participatory collaboration between the research team and practicing AP and PACU nurses to improve PITS.

Aims and Approach

This dissertation consists of three manuscripts that address the critical and complex nature of PITS: (1) a scoping review of the literature related to PITS, (2) an integrative review synthesizing instruments developed to measure and improve PITS, and (3) a sequential exploratory mixed methods study evaluating the feasibility of an electronic post-operative information transfer instrument. This dissertation research explores factors influencing PITS and assesses the feasibility of an instrument aimed at improving PITS and patient safety. The aims of this dissertation are:

AIM 1: *To perform a scoping review of the literature to map the current state of the literature related to PITS.*

AIM 2: *To describe and synthesize instruments developed to improve the quality of PITS.*

AIM 3: **Phase 1:** Using a participatory action research approach and sequential exploratory mixed methods, the research study will tailor a proposed electronic post-operative information transfer instrument (EPITI) based on key stakeholder's recommendations.

Phase II: To pilot test the electronic post-operative information transfer instrument during PITS.

Phase III: To assess the feasibility of implementing the EPITI using sequential exploratory mixed method, and to evaluate the EPITI for signal of effect on select post-operative patient outcomes through comparison of aggregate benchmark anesthesia patient outcome data pre- and post-implementation of the EPITI.

Conceptual Models

Two conceptual models, The Social Ecological Model and Donabedian Conceptual Model, underpinned and guided the conduct of this dissertation.

Social Ecological Model (SEM)

Originally a public health model, the SEM conceptualizes interdependent relationships among individuals, their behavior and the environment (Fleury &

Lee, 2006; Stokols, 1996). Not only does individual behavior affect the environment, individual behavior is also *affected* by the environment. From a social ecological perspective, greater attention is given to exploring social, cultural and institutional influences on the individual's behavior (McLeroy, Bibeau, Steckler, & Glanz, 1988; Stokols, 1996). Thus, the overarching paradigm of the SEM emphasizes dynamic relationship between individuals and their environments. Ecological models have been applied to research to conceptualize individual and environmental determinants of behavior (McLeroy et al., 1988). Environmental influences were divided into the micro-, meso-, exo- and macrosystem levels of influence. McLeroy et al. integrated several ecological models, including ecological models proposed by Bronfenbrenner, Belsky and Steuart, to develop a multi-level SEM (McLeroy et al., 1988). Figure 1 depicts five, nested hierarchal levels of the SEM.

Figure 1. The Social Ecological Model (McLeroy et al.)

From a public health perspective, the most effective approach to health care promotion is to address factors at each level of the SEM. When applied to studying post-operative information transfers, the SEM offers an innovative approach to analyze a multi-faceted clinical issue through a public health lens. Likewise, addressing factors at each level of the SEM can be applied investigating postoperative information transfers. The original five levels of the SEM were adapted to the following four levels: Intrapersonal factors, interpersonal factors, organizational environmental (i.e. PACU environment) and organizational policy.

Donabedian Conceptual Model

A framework was chosen to comprehensively examine and systematically investigate the multiple factors and components of post-operative information transfers (PITS). The Donabedian Conceptual Model (DCM) provides a framework for systematic inquiry and assessment of health care quality (Gardner, Gardner, & O'Connell, 2014; Haj, Lamrini, & Rais, 2013; Lawson & Yazdany, 2012). One of the premises of the DCM is that each dimension influences the success of the subsequent dimension (Gardner et al., 2014; Lawson & Yazdany, 2012). According to the DCM, health care quality should be measured and evaluated based on a multi-dimensional framework comprised of three interrelated dimensions, *structure, process and outcomes* (Haj et al., 2013). The *structure* dimension refers to the relatively fixed characteristics of health care

providers and the environment where healthcare is delivered (Haj et al., 2013; Lawson & Yazdany, 2012). Examples of *structure* include financial resources, training and organizational structure (Haj et al., 2013; Lawson & Yazdany, 2012). Activities related to the delivery of health care are included in the *process* dimension (Haj et al., 2013). *Process* is described as the intervention that provides patients with an improved outcome (Naranjo & Viswanatha Kaimal, 2011). Manipulation of processes, within the overarching structure, has the potential to improve the effectiveness of the intervention and therefore patient outcomes (Aday, Begley, Lairson, & Slater, 2004). Interpersonal relationships among providers and incorporating appropriate medical technology, including electronic health records (EHR), into health care delivery are examples of the *process* dimension.

The third dimension, *outcomes*, refers to determining the impact of implementing the intervention on metrics of health care delivery including patient outcomes, patient safety and quality of patient care (Aday et al., 2004; Haj et al., 2013).

Information content is the structural component of post-operative information transfers. The process of post-operative information transfers is related to interpersonal communication among providers who participate in information transfers. Outcomes are related to effect of post-operative

information transfers on patient outcomes. Figure 2 depicts the Donabedian Conceptual Model applied to PITS.

Figure 2 Donabedian Conceptual Model applied to PITS

The Manuscripts

Manuscript I:

Factors influencing postoperative information transfers: A scoping review (Rose & Newman, 2016)

A scoping review of the literature *maps* the current state of PIT literature. Because of the complexity of PITS, scoping review methodology is performed to gain clarity of the research subject and to guide subsequent research inquiries. One of the primary purposes of the scoping review is to identify key concepts and factors influencing the quality and execution of post-operative information transfers (Arksey & O'Malley, 2005). The scoping review methodological framework developed by Arskey and O'Malley guides the conduct of this review (Arksey & O'Malley, 2005). The following five stages are used as the framework for conducting the review: (1) identifying the research question, (2) identifying relevant studies, (3) selecting studies, (4) charting the data, and (5) collating, synthesizing and reporting the results. Data are collated and synthesized using the multiple levels of the SEM as coding categories. For the purpose of this review, the institutional level is referred to as the *organizational environmental* level and pertains to the PACU environment. The community and public policy level were combined to form the *organizational policy* level. Thirty-one research articles are included in this scoping review. From the selected articles,

information about factors at the four levels of the SEM used in this review is identified.

Individual communication styles, communication among providers, context specific guidelines, as well as influences of the PACU environment have been shown to influence the quality and efficiency of post-operative information transfers. Accordingly, the scoping review is underpinned by the Social Ecological model. Studies were evaluated by the primary author and categorized according to the adapted levels of the social ecological model. Results of the scoping review identify factors at each level of the social ecological model that influenced the quality and potentially patient outcomes related to postoperative information transfers.

Manuscript II:

Post-operative information transfers: An Integrative Review

After performing a scoping review of the literature, an integrative review of extant literature is presented to assess and evaluate instruments/and or checklists developed to improve the quality of PITS. One of the purposes of the review is to identify and synthesize studies that described how PITS have been studied and how research has developed instruments to systematically evaluate the quality and processes of PITS. The conduct of this integrative review is guided by Whitmore and Knafl's guidelines to support systematic development of an integrative review, including summarizing and synthesizing the current state of

the literature and identifying gaps in the literature (Gardiner, Marshall, & Gillespie, 2015; Whitley, 2016; Whittemore & Knafl, 2005). Seventeen studies are identified, contextually structured and compared to the Donebedian conceptual model (DCM) (Torraco, 2005).

Each study will be critically appraised and categorized into one of the three dimensions of the DCM. The level of evidence of each study are classified based on categories proposed by Wong et al.(Segall et al., 2012; Wong, Yee, & Turner, 2008). (Table 2). Seventeen studies are identified that developed instruments to address the structure, process or outcomes of PITS. Results of the integrative review suggest a need for continued development of instruments intended to measure aspects of PITS. Context specific instruments may not be generalizable to other practice settings. Therefore, additional research is needed to develop instruments that reliably measure post-operative information transfers across multiple clinical settings. One strength of the review is evidenced by the application of qualitative and participatory action research (PAR) methodologies. Designing a multimodal intervention that includes PAR is one approach to developing post-operative information transfer instruments.

Manuscript III:

Improving post-operative information transfers: Evaluating Patient Outcomes

Recognizing the multidimensional nature of PITS from the scoping review, the benefits of standardizing information transfers and the value of participatory action research from the integrative review, a pilot and feasibility study will be conducted to evaluate the feasibility of implementation of the EPITI into practice. The third manuscript of this compendium reports the feasibility results of pilot testing the EPITI. Participatory action research is used to develop and tailor the EPITI. AP and PACU nurses pilot tested the EPITI and assessed the feasibility of implementing the EPITI into practice. Results indicate the EPITI integrated well into practice and met the information needs of providers. Additional research is needed to develop and implement electronic post-operative information transfer instruments. Additionally, future research should identify quantifiable patient outcomes that are directly affected by PITS.

A multiphase mixed methods study was chosen to investigate a complex clinical problem, PITS, through an iterative process of connecting sequentially aligned qualitative and quantitative inquiries (Creswell & Clark, 2011). Each phase of the study builds upon previous work and culminates to achieve the study aims. The design provides an overarching framework which included multiple phases to investigate PITS.

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Manuscript I

Factors Influencing Patient Safety during Postoperative Handover

Factors Influencing Patient Safety During Postoperative Handover

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Patient safety continues to be a major concern for healthcare providers and organizations. Handovers, also called handoffs, serve as the transfer of postoperative care from the anesthesia provider to the postanesthesia care unit (PACU) provider. Ineffective handovers result in gaps in care and potential harm to the patient. We conducted a scoping review to identify key factors affecting patient safety during the process of postoperative handovers. We searched empirical literature examining factors associated with patient safety and postoperative handovers in the context of anesthesia, in the Cumulative Index to Nursing & Allied Health Literature, Ovid, Google Scholar, and The Joint Commission websites between January 2004 and March 2014. We excluded obstetric and cardiac anesthesia-related studies. A total of 31 articles met criteria for inclusion in the review. Factors at multiple levels of the Social Ecological Model affecting patient safety and handovers were identified. Intrapersonal factors included individual communication styles; interpersonal factors were related to anesthesia and to PACU provider team dynamics; organizational environmental factors described the dynamic PACU environment; and organizational policy-level factors included emphasizing a culture of patient safety. This scoping review demonstrates a multilevel analysis of factors affecting handovers and patient safety.

Keywords: Anesthesia, communication, handovers, patient safety, postanesthesia care unit.

The transfer of information from one provider to another, known as a *handoff* or *handover*, is critically important to patient safety. Handovers are complex events that contribute to a broad knowledge transfer that helps individual team members better understand the priorities for patient treatment and anticipate future plans of care.[1] *Postoperative handovers* are a critical phase of the surgical patient's perioperative care.[2] Ideally, postoperative handovers between anesthesia providers and postanesthesia care unit (PACU) nurses provide critical information about the patient, create an environment for mutual information exchange between the anesthesia provider (sender) and PACU nurse (receiver), and efficiently and effectively transfer patient care and responsibilities while adhering to organizational standards that promote patient safety.[3] Postoperative patients are in an "at-risk" state and require constant vigilance and assessment that can only be achieved with effective communication between the anesthesia provider and the PACU nurse.[1] Even with vigilance, however, surgical patients are more vulnerable to handover errors than are patients in other clinical areas because of the combined acuity and transition.[1]

Furthermore, the fact that postoperative handovers occur in dynamic environments where providers are multitasking heightens the potential for medical errors and loss of information. Observational studies of postoperative handovers have found evidence of ineffective communication between the anesthesia provider and the PACU nurse.[2-4] A root cause analysis reported by The Joint Commission suggests that poor communication is a major cause of anesthesia-related sentinel events.[3] This failure of communication can have dire consequences. In an observational study, potentially important items, such as estimated blood loss and changes in blood pressure, were not reported during handovers.[6] When information is inadvertently omitted, gaps in patient care and breaches in patient safety can occur.[3] Delays in treatment caused by omission of information have potentially deleterious effects on patient outcomes.[7] Of major concern are poor-quality transfers of patient information that lead to increased morbidity and mortality, increased length of hospital stay, increased healthcare costs, and poor patient satisfaction.[2]

Social Ecological Model

Research on surgical outcomes has primarily focused on the patient's physiologic factors, length of hospital stay, and complications directly related to the surgery.[8] Recently, a growing body of literature addresses the influence of factors such as communication, team performance, and the working environment on patient outcomes. Consistent with this evolving area of research, recognition has grown of the crisis related to ineffective postoperative handovers.[9] Postoperative handovers are multifaceted events that occur simultaneously with other patient care activities. Factors other than individual preferences and individual communication styles affect post-

operative handovers. Therefore, addressing a complex phenomenon such as postoperative handovers requires a multilevel model.

One way to conceptualize external factors related to patient outcomes is to examine handovers in the context of the Social Ecological Model (SEM). Designed to investigate complex public health issues, the SEM is grounded in core principles concerning "the dynamic relations between people and their environments."[10(p286)] The SEM implies a reciprocal, causative relationship between factors of the individual and the environment that ultimately influence behavior. Intrapersonal level factors of the SEM include characteristics, such as knowledge and attitudes, of the involved individuals, whereas the interpersonal level of the SEM describes relationships, processes, and interactions, whether formal or informal, between and among individuals and groups. The institutional level of the SEM describes factors associated with institutions and organizational characteristics, systems, and policies. The community level consists of relationships among institutions, and the public policy level refers to state and national laws and policies.[10,11]

The SEM provides a comprehensive guide for studying, describing, and analyzing causal relationships and factors that affect postoperative handovers. This model explicates how behaviors, in the activity of postoperative handovers between anesthesia providers and PACU nurses, are influenced by the involved individuals and the environment. By extracting and elucidating factors at each level of the SEM, postoperative handovers can be better understood and studied, with key factors identified that affect the quality and processes involved in conducting postoperative handover. As an example, human factors such as communication and teamwork affect postoperative handovers. Moreover, the PACU environment can be analyzed to investigate environmental factors influencing exchanges in information and patient care. For clinicians and administrators trying to improve quality and safety, exploring the attributes of postoperative handovers within the SEM allows for assessment of current practices and prospective planning for practice changes. Researchers interested in designing effective interventions to improve handovers need to account for factors on each level of the SEM. Figure 1 illustrates the SEM, as defined by McLeroy et al,[11] and Figure 2 shows the SEM as adapted from its original applications in public health.[12] Applying the SEM to analyzing postoperative handovers may identify a wider array of intervention points for restructuring and standardizing postoperative handovers. Once target points are identified, they can be addressed and improved on. Accordingly, the purpose of this article is to present a scoping review of the literature to identify multilevel factors, guided by the SEM, that influence postoperative handovers.

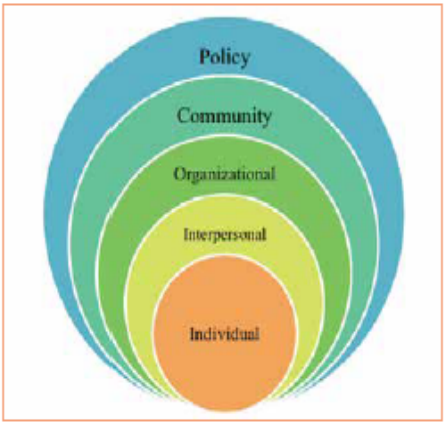

Figure 1. Social-Ecological Model

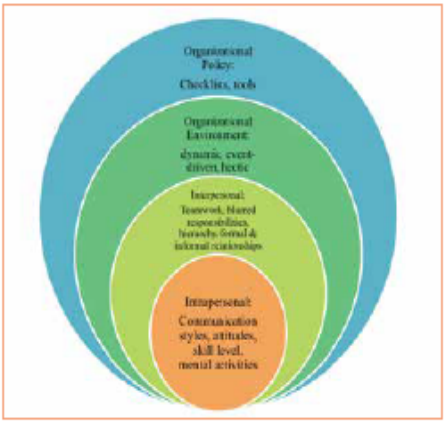

Figure 2. Factors Influencing Information Transfers, as Visualized Through an Adapted Social-Ecological Model (Adapted with permission from McLeroy et al.[11])

Methods

The scoping review methodologic framework developed by Arskey and O'Malley[13] guided the conduct of this review. We conducted a scoping review to obtain a broad view and perspective of the literature pertaining to postoperative handovers.[14] A scoping review is optimal for investigating complex research areas, as this type of review aims to rapidly "map" the current state of knowledge and identify gaps in existing research. In addition, scoping reviews provide an opportunity to "identify sources of evidence to inform practice, policymaking, and research."[15(p2)] The 5 stages of the framework for scoping are as follows: (1) identify the research question, (2) iden-

tify relevant studies, (3) select studies, (4) chart the data, and (5) collate, synthesize, and report the results.[13(p22)]

The electronic databases of PubMed, Cumulative Index to Nursing & Allied Health Literature, Scopus, and Ovid MEDLINE were searched in March 2015, with results limited to January 2004 through March 2015. Additional searches were conducted through Google Scholar, as well as The Joint Commission and the Agency for Healthcare Research and Quality home pages. Initially using keywords from important articles, we conducted broad literature searches. The outcome of this iterative process resulted in refining the keywords used in the initial search and combining those search terms with Medical Subject Headings (MeSH terms). With use of the Boolean term AND, the following groups of key search terms were combined with MeSH search terms: *anesthesia, postanesthesia care unit, PACU, recovery, surgical patients, recovery room, anesthesia nursing, perioperative nursing, handovers, handoffs,* and *communication.*

Eligible for screening were all articles pertaining to postoperative handovers that met the following inclusion criteria: handovers delivered by the anesthesia provider, defined as the anesthesiologist, anesthesia resident, or Certified Registered Nurse Anesthetist (CRNA), to either the PACU nurse (recovery room nurse) or the intensive care unit (ICU) nurse. Study selection involved applying post hoc inclusion and exclusion criteria.[13,15] Articles were eligible for inclusion if they described 1 or more factors at each level of the SEM. Studies assessing handovers in obstetric, pediatric ICU, and cardiac ICU settings were excluded because these settings and their providers are highly specialized. In addition, the reference lists of systematic review articles were searched.

After application of inclusion and exclusion criteria, 199 articles were identified. These 199 articles were "scoped" to identify articles that addressed any or all levels of the SEM. Data were complied, collated, and synthesized using the 4 levels of our adapted SEM as coding categories. Charting the data included extracting from each study the purpose of the study, study design, setting, and sample size. The original 5-level SEM was adapted to 4 levels for this study based on the results of the literature review. Furthermore, the SEM, which is a public health model, was adapted in the following ways to study a clinical event occurring in a healthcare organization setting: the institutional level is referred to as the *organizational environmental* level, and the community level and public policy levels were revised to form the *organizational policy* level.

Results

After applying inclusion and exclusion criteria and scoping the articles, we identified 23 for inclusion.

• *Intrapersonal Level.* Intrapersonal-level factors concern temporal attributes of the individual, individual activities, human factors related to communication styles and skills, and performance of activities related to handovers.

• *Communication Style.* Individual communication style during postoperative handovers was described as verbal and nonverbal.[16,17] Nonverbal communication included eye contact or lack of eye contact, posture, hand gestures, and how the providers were physically oriented in relation to others during the handover.[16,17] Verbal communication included clarity of speech and delivery of key patient-specific information.[16] Individual handover communication styles influenced the quality of information transfer.[1] For example, Smith et al[17] observed that some anesthesia providers' handovers contained language such as "*my usual*", implying the provider's assumption that the PACU nurse was familiar with the type of anesthetics delivered by a particular provider. Furthermore, individual communication styles were found to be largely informal during information transfers.[17]

• *Professional Background.* Handovers were described as involving providers from various professional backgrounds and skill sets, each with unique priorities during the handover process.[4,18] One study indicated that providers' tone of voice suggested familiarity between providers.[17] Familiarity often exists among providers who have long work histories and may imply a sense of unspoken trust among providers. Attributes of individual providers, such as attitudes about handovers, legibility of handwriting, level of experience, and professional aptitude, influenced the quality of handovers.[18,19] One study found that trainees engaged in more information-seeking behaviors than did experienced providers participating in handovers.[1]

• *Cognitive Processes.* Mental activities such as prioritizing and information recall were identified as significant intrapersonal factors as well. For example, various providers participating in postoperative handovers prioritized information differently[18,20] and had different expectations of information content.[17] Furthermore, providers were described as having different mental models, including how the patient's condition was conceptualized.[1] Members of the surgical team, such as surgeons and anesthesia providers, were described as having different perceptions of the surgical course compared with the ICU team.[20] One qualitative study used semistructured interviews to identify information transfer and communication gaps across the perioperative period.[19] Respondents reported that memory lapses occurred in which providers forgot to transfer critical pieces of information during the handover.[19] One study emphasized that the receiving providers' memory of information transferred during handovers was critical to providing seamless high-quality patient care.[21] In this study, the structure and duration of the handover significantly influenced the amount of information the receiving provider retained afterward.[21] Furthermore, multitasking,

in which providers were observed as being engaged in myriad other activities during postoperative handovers, was described in 5 studies.[17,19,21,22]

• *Interpersonal Level.* Interpersonal factors are the interactions, including interpersonal communication, team behaviors, and interpersonal dynamics of information transfers, that occur during handovers.

• *Dynamics Among Providers.* Interpersonal factors were described as interactions and information transfers between the 2 highly specialized teams: anesthesia providers on the one hand and PACU or ICU nurses on the other.[20] Interpersonal dynamics among providers were described as being different in postoperative settings compared with other patient transition points. For example, an article described a key distinctive quality of postoperative handovers: the delivering team is composed of the surgeon and the anesthesia provider.[20] In other settings, the delivering team is typically composed of 1 member such as a nurse or single physician. Furthermore, handovers conducted between the PACU and ICU nurses involve cross-discipline collaboration and a temporary merger of the surgical team with the ICU team of providers.[20] This difference in specializations is important because members of the delivering team are likely to prioritize and therefore communicate information based on their professional perspective of the handover event.[20] Another observational study described the dominant communication behaviors of transferring clinicians as "giving," assessment, planning and decision making, and handover management.[1] In contrast, the receiving clinicians' handover communication was characterized by acknowledging receipt of the handover and by information-seeking behaviors.[1] Differences in dominant communication behaviors reflect providers' organization and prioritization of information delivered and received during information transfers.

• *Teamwork.* Teamwork characteristics were explicitly identified as a significant interpersonal factor as well. Mazzocco et al[7] conducted an observational study to determine whether patients whose surgical teams demonstrated effective teamwork experienced better outcomes than did patients of teams with poor teamwork. Domains of behavioral markers of teamwork identified in this study were patient briefing, information sharing, inquiry, vigilance, and awareness.[7] Patients whose surgical teams exhibited poor teamwork during handovers were at higher risk of major and minor complications and death, after adjusting for the ASA physical classification system.[7]

The working atmosphere referred to the interpersonal relationships within the team of clinicians involved in the handover.[23] Tensions and blurred responsibilities among providers[23] contributed to communication failures, leading to ineffective handovers.[17,24,23] For example, Dee and Robb[23] found that providers were often unclear about who was responsible for airway management during handovers, whereas another study described responsibilities being negotiated between providers during handovers.[17] The transfer of patient information from the anesthesia provider to the PACU nurse did not automatically and simultaneously imply the transfer of responsibility.[17] In fact, the transfer of responsibility appeared to be contingent on mutual provider trust and balancing power between providers.[17] Furthermore, longstanding interpersonal relationships between anesthesia providers and PACU nurses were observed to encompass a sense of familiarity; in other words, anesthesia providers expected PACU nurses to recall more commonly used anesthetic techniques.[17] In addition, a theme that emerged from research on handovers was the PACU nurse's sense of being maneuvered into taking responsibility for a patient.[17] In 1 study, PACU nurses were unwilling to assume care of patients when they received what they considered to be an incomplete handover.[26]

Apical interpersonal relationships and timing of information transfers were identified as interpersonal factors. Four articles described hierarchy as an interpersonal factor influencing postoperative handovers.[19,20,27,28] One article defined the processes of OR to ICU handovers and found that hierarchy emerged as an inherent factor that exists among perioperative teams during handovers at their institution. Bonifacio et al[20] stated that hierarchy confounds interpersonal communication among providers. Another article found there was insufficient time allotted for receiving the patient before commencing information transfers.[29] Furthermore, 2 articles indicated the timing of postoperative handovers is a concern because often all parties are not ready to engage in information transfers.[19,20,28] Hierarchical relationships among providers can serve as a barrier to open communication among perioperative teams.

• *Quality of Information Transfer.* The quality and quantity of information transferred during postoperative handovers depended on interpersonal communication between anesthesia providers and receiving PACU and ICU nurses. Information omissions and incomplete handovers were characterized by providers failing to verbally communicate pertinent information during handovers.[16] Five articles described information omissions as provider-related activities.[2,4,6,19,29] For example, 1 observational study found that 66% of patient-specific and 67% of anesthetic-specific information was transferred during handovers.[4] After observing postoperative handovers using a 24-item postoperative assessment tool, another study found 9.1 omissions per handover.[2] Milby et al[30] found that 72% of patients with diabetes were identified as having the disease to the PACU nurse during handovers, whereas 40% of the patients with heart failure were identified, suggesting variations in the content of handovers.

Anwari[31] studied the quality of handovers from anes-

thetists to PACU nurses by querying PACU nurses via a questionnaire. The results revealed that 67% of anesthetists failed to deliver the 5 points of information considered essential: preoperative status, premedication details, operation details, intraoperative course and complications, and intraoperative course and anesthesia-related complications and intraoperative analgesia.[31] In another study, handovers were shown to be incomplete and rarely included information such as postoperative pain management.[30] Siddiqui et al[6] developed a checklist from the institution's anesthesia record to identify specific items communicated by the anesthetist to the PACU nurse during handovers. The checklist included 4 sections: the patient's preoperative physical status, intraoperative details and anesthesia management, important intraoperative events, and postoperative directives.[6] Items on the checklist that were not communicated by the anesthesia provider greater than 88% of the time during the handover included patient positioning, estimated blood loss, and ASA physical status.[6] This study found that anesthesiologists did not communicate intraoperative interventions, such as fluid amounts, antihypertensive therapies, and placement of invasive lines, to PACU nurses.[6] The authors, Siddiqui et al,[6] also found a gap between what information is actually reported during handovers and what information anesthesiologists believed should be communicated during handovers. Another study found that only 55.8% of patient, surgical procedure, and anesthesia-related information included on the Information Transfer and Communication Assessment Tool for Surgery was transferred from the OR to the PACU during postoperative handovers.[4] One observational study described information transfer that lacked critical patient information, such as prolonged postextubation oxygen desaturations.[17] Nurses in the PACU reported difficulty in prioritization of fragmented information delivered by the anesthesia provider.[23]

• *Organizational Environmental Level. Organizational environment* describes the setting of the PACU or ICU in which handovers take place.

The operating room and the PACU are considered two of the most complex environments in healthcare.[3] In fact, the PACU is described as event driven and distraction rich, where PACU nurses respond to spontaneous, emerging patient events.[17,20] The situation is time pressured because split-second decisions must be made to maintain patient safety.[17] The PACU environment is dynamic because of frequent patient admissions, discharges, and transfer of patients in and out of the unit.[32] Multidisciplinary teams must respond to unpredictable workloads, care for patients in a vulnerable state,[33] and collaborate to provide safe and effective care. Moreover, patient care in this environment encompasses many interventions and practices to promote safety and efficacy[32] that must also be executed in a time-pressured environment.[23] Furthermore, time pressures associated with the operating room and case turnovers may cause providers to curtail patient information during handovers.[20] Petrovic et al[28] mapped the transfer of patients from the OR to the ICU. Several factors, such as limited writing space, poor lighting, interruptions, and background noise were identified as limitations during information transfers.[28]

In the literature, anesthetists' handovers took place amid a variety of other activities that compete for the PACU nurses' attention. One study found that distractions and interruptions during handovers were numerous and often necessary to address other patient concerns and execute time-sensitive interventions.[21] Smith and Mishra[26] analyzed handovers and noted that many staff members were transiently present during the handover process, including surgeons, nurse practitioners, patient care assistants and patient transporters.[26] Together, these distractions and interruptions formed barriers to safe handovers.[26] Furthermore, 2 studies found that interruptions occurred in about half of the observed handovers. Distractions by support personnel during handovers and increased noise levels related to equipment may be accepted elements of PACU environments, therefore perpetuating a distracting environment.[26] Additional auditory distractions, such as pager alarms, monitor alarms, and phone calls, make the PACU work environment a less-than-ideal environment for handovers.[20,21]

• *Organizational Policy Level. Organizational policy* refers to structured frameworks, such as tools and checklists, designed and implemented by healthcare organizations to streamline and improve the quality of postoperative handovers. In addition, factors at the organizational policy level refer to context or unit protocols designed and institutionally adopted to standardize information transfers. Several studies discussed development and implementation of checklists and tools to standardize postoperative information transfers.[18,29,34-36] However, most interventions were not governed or directed by overarching institutional guidelines; instead, they were provider initiated.

Nagpal et al[2] found that developing and implementing preestablished (existing) standardized tools and checklists improved efficiency of handovers, enhanced current high-quality care practices, and decreased sentinel events surrounding the perioperative period. De Vries et al[37] implemented a comprehensive checklist, the surgical patient safety system (SURPASS), that was divided into preoperative, operative, recovery or intensive care, and postoperative stages of the surgical pathway. After implementation of SURPASS, the number of postoperative complications was reduced from 27.3 per 100 patients to 16.7 per 100 patients.[37] Results of this study suggested that interventions, such as checklists and smart cards, reduced information transfer and communication failures and improved work flow.[37] Other researchers found

that implementation of the Perioperative Handoff Tool for information transfer from the OR to PACU improved information sharing, increased provider satisfaction, and decreased distractions during the handover process.[28] After implementation of a handover protocol, another study found significant reductions in both information omissions and task errors, including oxygen masks and monitor setup.[29] Finally, Mardon et al studied the relationships among 8 postoperative patient safety indicators and the Hospital Survey on Patient Safety Culture sponsored by the Agency for Healthcare Research and Quality.[38] The study found that hospitals with higher scores on patient safety culture tended to have fewer documented adverse events.[38]

Discussion

The findings from this scoping review add a different perspective to the extant literature through the use of the SEM to investigate the multiple factors that influence postoperative handovers. Application of the SEM provides a structured, overarching framework for systematically identifying interrelated factors influencing the complex information transfers associated with handovers.[10,11] In fact, the SEM was designed to study complex events with multiple interrelated parts. Through use of scoping methods underpinned by the SEM, this review gained broad perspectives of the complexities of information transfers in the postoperative setting. The SEM provides a unique perspective to identify leverage points related to postoperative handovers within institutions.

• *Recommendations*. The primary goal of postoperative information transfers is to safely and efficiently transfer care of the postoperative patient from one skilled provider to another. Therefore, researchers and providers interested in improving the quality of handovers and promoting patient safety need to seek input from frontline providers to determine the best courses of action for addressing factors that negatively influence postoperative information transfers. Intrapersonal factors, such as individual communication styles and nonverbal communication, are not easily amenable to change. To better understand the impact of these factors, clinicians interested in improving information transfers should develop multidisciplinary platforms to allow providers to distinguish their concerns and perceptions of their roles during postoperative handovers. Verbalization of providers' thought processes involved during information transfers can reduce misperceptions and misconceptions related to interpreting certain communication styles. For example, communication, both verbal and nonverbal, and teamwork influence interpersonal interactions during information transfers. In some practice settings, providers have longstanding relationships in which verbal and nonverbal cues are inherently understood. Likewise, among these longstanding relationships, providers may feel like they are valuable parts of a functional and efficient perioperative team where each member and their input are valued. One study found that patients whose surgical teams exhibited strong teamwork behaviors had better outcomes.[7] This finding should be explored in future research by examining and identifying which specific aspects of communication and teamwork among providers results in positive patient outcomes. Because surgical teams are familiar with their patient populations, work environment, and workload, quality improvement administrators should solicit recommendations for quality improvement measures from providers who routinely participate in information transfers.

Because PACU nurses and anesthesia providers prioritize differently, additional research is needed to examine providers' mental sequences of prioritization during postoperative handovers. Once providers understand how each other approach and prioritize, information transfers can be tailored to align more closely with providers' expectations for postoperative handovers. Thus, restructuring information transfer processes moves toward achieving shared understanding among providers, especially related to meeting provider expectations during information transfers.

Providers' styles in communication, level of prioritization, and perceived importance of the event[3] were identified as intrapersonal factors that influenced information transfers. One consequence of providers focusing on their individual priorities was that the receiving PACU nurse experienced information overload during the handover by the surgical team, including the anesthesia provider.[22,23] When providers are overloaded with information, prioritizing and retaining pertinent pieces of information is difficult. In general, anesthetists communicate information that they believe to be relevant to the handover process, including the type of anesthetics used, patient-specific information such as comorbidities, and pertinent intraoperative events. In fact, some clinicians believe that information is the *property* of certain providers. Individual communication behaviors, including *giving, assessment, acknowledgment*, and *planning and decision making*, have been studied to improve the understanding of team processes supporting effective patient handovers.[17,19] Issues related to relevance and ownership are problematic when they lead to a lack of shared understanding between providers and place patients at higher risk of perioperative complications and mortality. Familiarization with communication styles and prioritization processes promotes shared understanding among providers. Specifically, providers are equipped to manage and interpret information transferred during handovers because providers are familiar with local staff and practices.

Regarding providers having a sense of ownership of information, this may not be detrimental to postoperative handovers, particularly if the receiving team is not ready

to assume responsibility of the patient. In this regard, the anesthesia provider still "owns" critical patient information and is therefore still responsible for initiating treatments and interventions if the information requires patient care interventions. For example, if the anesthesia provider claims ownership of critical information such as the results of an arterial blood-gas analysis associated with a ventilated patient, and the anesthesia provider has not transferred the patient to the PACU nurse, the anesthesia provider is the logical provider to initiate appropriate interventions. Hierarchy, defined as a gradient in authority, exists among surgical and anesthesia teams.[39] Furthermore, apical relationships can serve as a barrier to effective communication and teamwork. For example, junior providers may feel reluctant to introduce their knowledge and level of understanding of clinical events because they are lower on the totem pole of providers. Consequently, if junior-level providers observe questionable behaviors and practices of senior providers, junior providers may remain silent because they fear negative professional consequences. The negative impact of hierarchy is that junior team members feel inferior and marginalized as a team. Furthermore, junior team members may yield to more dominant roles. To address the negative impact of hierarchy among surgical and anesthesia teams, providers interested in improving information transfers should consider simulation training to offer instances for providers to assess their communication and interpersonal skills.

It is challenging, if not impossible, to change the way that providers conceptualize patients' conditions[1] because of differences in educational backgrounds, training, and provider roles and responsibilities during handovers. Likewise, providers have different perspectives about anticipatory planning during information transfers. Providers could gain a better understanding and appreciation of each other's perspectives of postoperative handovers by participating in situation-based clinical scenarios. For example, Nestel et al[16] rotated surgeons and anesthetists through the following 3 roles to improve handover communication skills: provider, observer, and consultant. Instead of evaluating communication, a similar educational session could be designed to allow providers to share their different perspectives of postoperative handovers. By discussing different perspectives of information transfers, providers will move toward shared understanding and gain appreciation of information transfers from a different perspective.

• ***Human Factors Research.*** Because this review identified a study examining memory and information retention, it is worthwhile to discuss human factors research. Human factors is a discipline that draws from cognitive psychology and sociology.[16] In addition, human factors research examines the interface between individual behaviors and the work environment.[16] Only sporadic evidence exists of specific implications of human factors, such as provider fatigue, on postoperative handovers. In the ICU handover setting, human factors research has mainly explored the effects of stress, fatigue, and memory load, on quality.[38] For example between the years 2004 and 2014, The Joint Commission conducted a root cause analysis and found that 60% of anesthesia-related sentinel events were related to human factors.[40] In a prospective study of patient safety in the operating room, individual factors that influenced patient safety included the provider's cognitive and perceptual processes, level of expertise, individual experience, temperament, and situational awareness.[41] Thus, human factors research has produced valuable information aimed to improve the quality of postoperative handovers and patient safety. This line of inquiry needs to be pursued further in the PACU setting. Measurable human factors such as provider fatigue, teamwork, and workload should be studied to determine their influence on the quality of postoperative handovers.

• ***Barriers to Communication During Handovers.*** The interpersonal context of clinical handovers is an important determinant of interprofessional interactions. Effective communication among perioperative team members is an essential component of providing quality and safe healthcare. Effective handovers are largely dependent on the interpersonal communication skills and interactions between the anesthesia provider and the PACU nurse. A lack of teamwork during handovers has been associated with increased postoperative complications. Safety experts stress that individuals' interactions with each other are critical determinants of errors. In addition, Mazzocco et al[7] found that patients whose surgical teams exhibited teamwork behaviors were at lower risk of perioperative morbidity and mortality, after adjusting for ASA classification. However, teamwork during handovers is challenged by the involvement of providers across professional groups with different skill sets and different expectations of the handover process. Indeed, hierarchical relationships among surgeons, anesthesiologists, and PACU and ICU nurses exist and could serve as barriers to communication.

A concerning finding was that some PACU nurses believed they were being maneuvered into assuming care of patients during the handover process. Nurses in the PACU should safely assume responsibility of postsurgical patients after the provider voices that he or she is comfortable with the level of information received during the handover and when the patient is hemodynamically stable and has a stable airway. Also, information omissions were identified as a major interpersonal factor influencing information transfers. Deficits in information transfers can lead to delays in treating and assessing for disease-related perioperative complications that may exist alongside anesthesia and surgical complications. Assuming care of patients with incomplete information

sets the stage for medical errors and gaps in patient care.

On admission to the PACU, patient information and technology are transferred from the anesthesia provider to the PACU nurse. Providers must perform multiple clinical tasks while transferring information and responsibility, which requires providers to multitask while participating in information transfers. Multitasking during handovers divides providers' attention during handovers. Distractions and interruptions during handovers lead to communication errors and information omissions.[9] Consequently, critical pieces of information may be missed and need to be repeated. Incomplete, fragmented handovers may be transferred, which could be detrimental to patient safety and postoperative outcomes.[1,3] Therefore, the timing of information transfer during handovers is an important factor to consider and should be mutually agreed on between the sender and receiver. For example, when the anesthesia provider arrives to the PACU and observes the PACU nurse engaged in or distracted by other patient care activities, information transfer should be adapted or modified so that a complete handover is achieved. Providers should set aside mutually agreed on, designated times during handovers for information transfer and patient assessment.

Segall et al[9] suggested limiting conversations to patient-related topics during handovers and performing essential tasks before initiating handover communication. Thus, quality improvement initiatives aimed at addressing organizational policy-level factors are needed to reduce the incidence of distractions and interruptions during handovers. Several studies suggested limiting distractions during handovers.[2,22,36] For example, the "sterile cockpit" concept borrowed from the airline industry refers to locking the cockpit during takeoff and landing to minimize interruptions.[42] Applying a similar "lockout" concept to handovers, in which conversations and tasks are limited to immediate patient care, is a reasonable approach to simplifying communications during handovers.

Many of the existing problems with handovers, such as poor quality, inconsistency, lack of structure, and information omissions are attributed to a lack of framework and standardization.[43] Focusing (drilling down) on organizational-level and policy-level factors, such as standardization of protocols, appears to be an attainable target point of intervention to improve postoperative handovers. Research supports the premise that significant improvements in the quality, efficiency, and efficacy of handovers occur when the handover process is standardized. Existing studies demonstrate improvements in the quality and quantity of postoperative information transfers as well as provider satisfaction after implementation of handover tools.[28,29,33,44,45] Standardization of information transfer reduces variability among information transfers and provides structured communication goals for handovers. Additionally, development of standardized instruments should reflect current National Patient Safety Goals. By developing and implementing standardized handover protocols, institutions will align their quality improvement efforts with The Joint Commission's requirement of healthcare organizations to "implement a standardized approach to 'handoff' communications."[41(p8)] Studies suggest that documenting and formalizing the handover may serve many functions, including improving communication skills and providing evidence of clinical decision making.[10]

Potential limitations related to standardizing information transfers include lack of personalization and the addition of another step in an already involved process. Some providers may be resistant to changing traditional handover practices. Anesthesiologists in 1 study agreed to use a handover checklist during data collection phases of the study, but stated the checklist would not be used in normal everyday clinical practice.[35] Introducing checklists into an already time-pressured environment, such as the PACU, creates another task for providers to complete. Furthermore, standardization of checklists requires development of context-specific and ecologically feasible handover tools. Thus, it is critical to obtain input and direction from providers when standardizing postoperative information transfers. Although checklists were shown to increase the quantity of information transferred,[29,35] it was not clear if standardizing handovers increased the PACU nurses' level of understanding of perioperative information.

Conceptual frameworks are used to clarify concepts and propose relationships between those concepts. When describing handovers, conceptual frameworks and the SEM consider the complex interactions between providers and delivery of information. For example, Cheung et al[46] discussed 4 conceptual handover aspects: *information processing, stereotypical narratives, social interaction,* and *resilience*. Botti et al[27] developed a framework to examine the clinical handover. The framework addresses valid, practical tools, and measures of safety and quality in handovers specific to PACUs. The framework also assesses team performance during handovers, analyzes aspects of interprofessional communication, and is framed by safety culture and sustainability. Additionally, the Donabedian framework was designed to evaluate healthcare quality.[47] Combined with other frameworks, the Donabedian framework has been used to identify gaps in the measurement of handovers and to evaluate the structure, processes, and outcomes.[47] Application of 1 or more of these frameworks to real-life situations could unveil other aspects of handovers, such as the role of distractions during handovers on provider memory loss and information retention.

• ***Study Limitations.*** This review identified targeted articles that discussed factors reflected in the SEM that influenced postoperative information transfers. It should be noted that other factors, such as patient acuity and

different types of PACUs, influence postoperative information transfers. Also, most of the sample sizes of these studies were small, although theme extraction was consistent throughout the review. Handovers take place in other practice settings, such as the emergency department, as well as intrahospital handovers between physicians and between nurses. Additional information to improve postoperative information transfers can be gained by studying information transfers in other settings. Finally, among the studies reviewed, there were no randomized controlled trials, the gold standard for producing evidence-based research to inform and affect practice changes.

Conclusion

Postoperative information transfers are critical point-of-care transitions. It is essential to optimize communication among providers and to design ecologically valid and feasible information transfer practices. Standardizing information transfers has been shown to increase the amount of information transferred and to improve provider satisfaction with information transfer processes. However, future research needs to systematically evaluate the influence of standardized information transfer practices on patient-specific outcomes. Additional research is needed to determine if there are positive correlations between the quantity of information transferred and integration of information into care. Future research should link the quality of postoperative information transfers to patient-specific outcomes. Moreover, simulation-based research on handovers could address interpersonal communication issues encountered during information transfers. Addressing factors that negatively influence information transfer is critical to patient safety.

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DISCLOSURES

The authors have declared they have no financial relationships with any commercial interest related to the content of this activity. The authors did not discuss off-label use within the article.

Manuscript II

Post-operative information transfers: An integrative review

Abstract

Purpose: The purpose of this integrative review was to synthesize and critique the literature related to protocols, checklists and tools designed to facilitate information transfers from the operating room (OR) to the PACU and to provide guidance for selecting an appropriate instrument.

Design: This study is an integrative review of the literature.

Methods: Guided by Whittemore and Knafl's framework, an integrative literature search was conducted and included literature sources dated January 2000 and January 2015. Key words included: postoperative handover(s), handover(s), handoff, postoperative handoff, communication, information transfer, checklists, tools, measurement, communication, postanesthesia care unit (PACU). Articles were selected that described development of post-operative information transfer instruments.

Findings: Seventeen articles were identified. Instruments described in the articles were tabled and synthesized based on a priori categories described by the Donabedian Conceptual Model.

Conclusion: Developing an instrument to improve post-operative information transfers should integrate recommendations from front-line providers and information from existing instruments.

Introduction

Information transfers, patient handovers or *handoffs*, are defined as the transfer of critical and essential patient information, professional responsibility and accountability for patient care from one healthcare provider to another.[1–3] In the context of anesthesia, post-operative information transfers (PITS) are conducted between anesthesia providers (AP) and post-anesthesia care unit (PACU) nurses, as well as intensive care unit (ICU) nurses. Effective handovers are associated with continuity of patient care and safe provider transitions.[4] Ineffective postoperative handovers, which are essentially communication errors, result in gaps in patient care, information loss, delays in treatment, adverse events, and increased length of stay.[1,2,4,5] In fact, the Joint Commission (2012) estimates that 80% of medical errors involve miscommunication between providers during handovers. Lack of a standard structure during PITS has been associated with information omissions, decreased provider satisfaction with PITS processes, and long term consequences for the delivery of safe patient care.[5–7] Recognizing handovers as a high-risk area for patient safety, government and professional organizations have launched various quality improvement initiatives. In 2001, the Institute of Medicine (IOM) issued a pivotal statement noting that inadequate handoffs are "where safety often fails first."[7 (p.45)] Following this statement, the Joint Commission's 2006 National Patient Safety Goals required

that all healthcare providers implement a standardized approach to handovers, and this goal is currently a patient safety standard.[8]

One approach to improve patient safety and communication among providers is to develop and implement standardized PITS protocols.[9] Atul Gawande, noted surgeon and author of *The Checklist Manifesto,* posits that healthcare providers can improve patient safety by implementing and utilizing checklists in their practices.[9] According to Gawande, checklists provide a methodology for organizing and structuring large volumes of complex information.[9] Other previously described approaches for improving information transfer during PITS include development of a postoperative handover protocol based on consultations with Formula 1 car racing training teams, where pit stops are choreographed and highly structured, and aviation training team captains.[10] Using these protocols, Catchpole et al. reported a decrease in the mean number of information omissions from 2.09 to 1.07 during postoperative handovers from the operating room to the pediatric intensive care unit.[10] There have been numerous studies that have investigated and analyzed processes involved with PITS. Likewise, instruments have been developed to assess the quality of postoperative handovers and the communication of essential information during handovers.[2,10–15] The information content and the processes associated with PITS have been studied extensively, and the literature establishes a persuasive case for protocol-directed PTIS processes. Selecting an instrument to assess

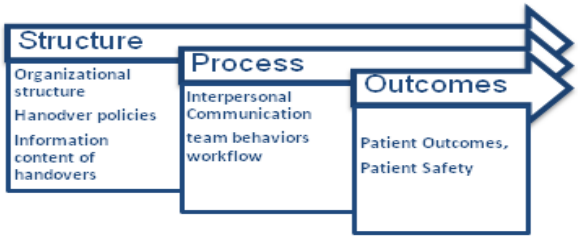
and standardize PITS is dependent upon the facet of PITS under investigation. Facets of PITS include: structuring information content by developing standardized checklists, structuring processes of the PITS to organize and engage members of the surgical, anesthesia and PACU nurse teams, efforts to minimize distractions and interruptions during PITS, information omissions, reducing barriers to successful PITS, and developing checklists to decrease high risk event and to improve patient safety.[2]

Given the numerous PITS protocols, checklists, and instruments available in the literature, AP, PACU, and ICU providers seeking to standardize PITS are faced with the daunting task of selecting a content- and context-appropriate instrument. The primary aim of this integrative review is to synthesize and critique the literature related to protocols, checklists and tools designed to facilitate PITS from the operating room (OR) to the PACU. This paper aims to: report how PITS protocols, checklists and tools have been developed, investigated, and evaluated, to describe how instruments have been developed to improve the quality of PITS, and to provide direction for future investigation. Herein, the PITS protocols, checklists, tools, pathways and protocols identified in the literature will collectively be referred to as *instruments* if the instrument in the study was not formally named.

Conceptual model

The Donabedian conceptual model (DCM) provides a framework for systematically evaluating healthcare quality and services. [16,17] According to the DCM, healthcare quality and innovation should be evaluated based on three quality of care dimensions.[18] *structure*, characteristics of the healthcare setting; *process*, clinical activities performed in the healthcare setting; and *outcomes*, patient and clinical outcomes resulting from a predetermined set of activities.[19] *Structure* is defined as the setting where healthcare is given.[20] The structural dimension can be applied to organizational and departmental levels depending on nature of the desired intervention [21]. The structural environment of the PACU is complex and influenced by unit policies, procedures, standards of care and unit specific PIT practices [21] Unit specific policies include the organizational structure of PITS, including methods to document PITS information. In this review, *structure* will also encompass the information content of the handover which is guided by unit specific practice standards. *Process* refers to the mechanisms, such as information transfer, communication strategies, and the sequencing of events that affect the manners in which PITS are conducted between AP and PACU nurse. Transferring patients from the OR to the PACU requires proper sequencing of information and events. The anesthesia provider is responsible for transporting the anesthetized patient from the OR to the PACU, while performing therapeutic and monitoring tasks.[2] Upon arrival to the PACU, monitoring technology is reestablished while patient information is communicated

to the receiving PACU nurse. This sequencing of events takes place in what has been described as an event driven and time pressured environment.[2,22] Moreover, the PACU nurse is largely unfamiliar with the receiving patient and may be simultaneously involved in recovering another patient. *Process* mechanisms include verbal and nonverbal cues and interpersonal relations among team members. Further, *process* refers to the tasks or activities necessary to safely and effectively complete a PITS. Behaviors such as interruptions and distractions during PITS are also related to process mechanisms. Processes related to PITS are directly affected by *who* participates in PITS as well as *when* (i.e. timing) PITS are conducted. The third dimension, *outcomes*, refers to the impact of the PITS on patient outcomes, patient safety and quality of care. Figure 1 depicts the DCM applied to PITS.



Methods

This integrative review was guided by the framework described by Whittemore and Knafl.[23] This methodological framework guided analysis and

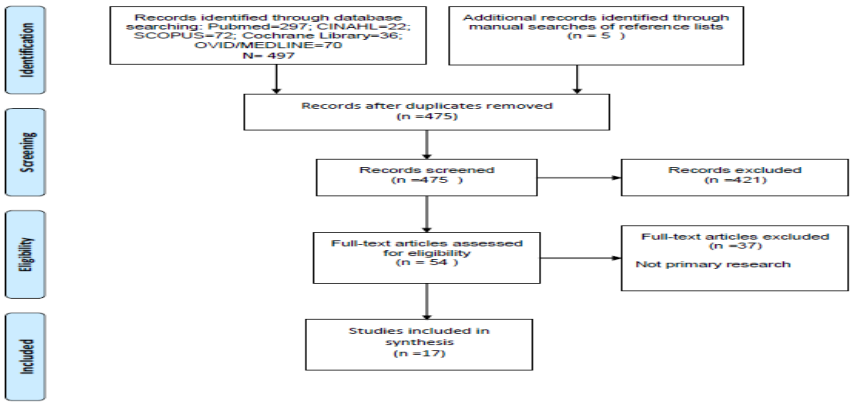
reporting of the current state of knowledge on complex constructs, such as PITS. Data analysis and synthesizing strategies included identifying the problem, describing the literature search strategy, evaluating the data and its quality, and reducing/synthesizing the data.[23] Visualization of primary data sources indexed within a single table (Table 1) allowed for identification of common themes across multiple data sources.[23]

A systematic search of the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Pubmed, SCOPUS, the Agency for Healthcare Research and Quality (AHRQ), and the Cochrane electronic databases was performed using the following search terms: postoperative handover(s), handover(s), handoff, postoperative handoff, communication, information transfer, checklists, tools, measurement, communication, postanesthesia care unit (PACU), postoperative, patient handoff, health communication, interdisciplinary communication, hospital communication systems, and inter-personal relations. Manual searches of the reference list of relevant systematic reviews were performed. The following MeSh search terms were entered into Pubmed and were integrated using the Boolean terms “AND” and “OR”: patient handoff, post anesthesia nursing, checklist, and communication.

A title and abstract review of the 497 articles retrieved identified 54 articles requiring further analysis using the following inclusion criteria: studies published between January 2000 and January 2015 that described instruments, including

checklists and tools, developed to improve the quality of PITS. In addition, instruments developed to improve the quality of the information content and structure of PITS as well as instruments developed to assess processes related to transferring the care of patients from the OR to the PACU in the adult setting were eligible for review. Retrieved systematic reviews were manually examined for empirical research related to PITS instruments. Following review of the articles, 17 research studies that described instruments designed to evaluate and improve the quality of PITS between AP and PACU nurses were retained for inclusion in the review. Figure 2 depicts a prisma flow diagram of the literature review.

Figure 2. Prisma Flow Diagram of Literature Search



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org.

Data extraction

Data extraction was independently completed by the primary author, who thoroughly read and categorized each article according to study design, setting, sample, aims, instrument description, level of evidence, and results (Table 1). Finally, each instrument described within the article was classified according to the three dimensions of the DCM, which are structure, process, and outcomes, addressed. One of the goals of classifying the instruments was to identify instruments that were developed to improve the structure, process or outcomes related to PITS, or a combination of these three dimensions.

Table 1 Postoperative information transfer articles included in this review.

Reference	Study Design	Sample	Setting	Aim	Instrument Description	Level of Evidence
Anwari (2002)[1]	Survey	After receiving every fourth patient, the PACU nurse caring for the patient completed a survey related to the quality of the handover of the patient on admission	PACU of an armed forces hospital	To assess the quality of handovers delivered by anesthetists to PACU nurses Purpose: evaluate quality of POH	Survey description: four subgroups: VIS (verbal information score) assessed whether five points of information regarding the patient and intra-operative course were communicated to PACU nurse; PCS (patient condition score) included level of consciousness, and stability of vital signs, ABS (anesthetist behavior score) determined whether anesthetists stayed in the PACU to assess first set of post op vital signs, and NSS (nurse's satisfaction score) assessed whether or not post - operative management of the patient was communicated and PACU nurse satisfaction with the handover	Category 3
Gilliken et al. (2016)[2]	Pre/post observational, intervention within-subjects design	16 full and part time CRNAS; 82 patient care transfers observations pre-intervention; 75 post intervention patient care transfers	Community hospital	To compare the incidence of information omissions prior to and after implementation of an electronic patient care transfer tool	Electronic postoperative instrument contained within the electronic health record; information recorded included: name, allergies, health history, surgical procedure, airway, intra-operative events, hemodynamic status, medications, state of muscle relaxation, fluid status, laboratory values and anticipatory	Category 3

					guidance	
Manser et al. (2010)[3]	Unstructured field observations	126 handoffs, three handoff settings; Kaiser-Meyer-Olkin measure of sampling adequacy of 0.81	Tertiary care setting, 3 different handoff settings paramedic to emergency room, anesthesia provider to PACU nurse, PACU nurse to ward nurse	To determine the characteristics of a safe and quality handover. To determine which handover characteristics predict handover quality Purpose: how do behaviors affect POH	19 item tool: 16 items rated on a four-point scale, 1 item handoff quality, 2 items assessed time pressure	Category 3
Mazzocco et al. (2009) [4]	Qualitative, Observational with Retroactive chart review	293 observed cases A priori power analysis 0.95	Operating rooms (OR) of 2 medical centers and 2 ambulatory surgery settings; total of 4 sites	To determine if patients of surgical teams who exhibited strong teamwork had better outcomes than patients of teams with poor teamwork Purpose: how do behaviors affect POH i.e. patient outcomes	**Instrument**: (BMI) behavioral markers instrument; (BMRI) Behavioral Marker Risk Index: Observed scores from BMI converted to a single score teamwork behaviors of the perioperative team , no description of BMI	Category 2
Milby et al. (2014)[5]	Prospective observational study-handovers were observed prior to and after implementing the checklist	Single observer observed 798 postoperative handovers; 790 postoperative handovers included in the study	Large teaching hospital in Germany	To analyze information transfer during postoperative handovers Purpose: evaluate the quality of POH	59 item checklist divided into preoperative (patient data, ASA status, co-existing diseases, medical history) intraoperative (postoperative nausea and vomiting prophylaxis, airway management, type of surgery, antibiotic management, blood loss and anesthesia related events) and postoperative information	Category 3
Nagpal, Arora, Abboudi et al. (2010)[6]	Qualitative, semi-structured interviews	Phase I: 18 healthcare professionals (surgeons, anesthetists, nurses, theatre, recovery and ward) Phase II 50 professionals from three hospital sites, Used a qualitative sampling frame	Various hospitals where providers worked	To determine information transfer failures and problems, define responsibilities for information transfers, to develop and validate an evidenced based handover protocol	POP-Postoperative handover protocol 28 item checklist; check list designed to identify most relevant information related to handovers to improve handovers	Category 3

(Nagpal, Vats, Ahmed et al. 2010)[7]	Qualitative Observational	Multidisciplinary team of surgeons, anesthetists, nurses, psychologist, handovers of 20 patients	Large teaching hospital in London; gastrointestinal surgical department	To develop a framework to evaluate information transfer and communication; To identify information transfer and communication failures Purpose: evaluate the quality of POH	ITCAS (Information Transfer and Communication Assessment Tool for Surgery)	Category 1
(Nagpal Abboudi, Fischler et al. 2011) [8]	Observational	100 handovers (n=50 at each site)	Data collected across two large acute teaching hospital sites	To develop an instrument that can be used to evaluate quality of postoperative handovers Purpose: evaluate the quality of POH	Postoperative handover assessment tool (PoHat), 24 item checklist	Category 1
Nagpal Abboudi Manchanda. (2013)[9]	Prospective pre-post intervention; direct observation of handovers	Total 90 handovers; 50 before and 40 after introduction of handover protocol	PACU of an acute teaching hospital	To develop a handover protocol to improve the quality of POH	Postoperative handover assessment tool (PoHat), 24 item checklist	Category 1
Petrovic et al. (2012)[10]	Exploratory; quantitative and qualitative exploration	Anesthesia providers, surgeons, and nurses at all levels of training; multidisciplinary team including nurse practitioners, physician assistants and intensivists, anesthesiologists and surgeons	Departments of Anesthesiology, surgery and nursing in the cardiac surgical intensive care unit; Johns Hopkins Hospital	To develop a checklist to guide anesthesia and surgery reports, patient handovers, from the operating room to the ICU/PACU	The anesthesia checklist is part of a larger postoperative handover protocol. The anesthesia checklist includes pre-op information, intraop information and post-op guidance information; the anesthesia provider delivers their report following the surgical report delivered by the	Category 2

					surgeon	
Petrovic et al. (2015)[11]	Prospective, pre- post intervention, unblended study	53 handovers were observed pre-intervention, 50 handovers were observed post-intervention; 105 surveys completed pre-intervention and 142 surveys completed post intervention; providers who completed the survey were members of the surgery, anesthesia, OR nurse and PACU nurse teams	Peri-anesthesia care unit, tertiary level facility	To design and evaluate the use of a perioperative handoff protocol implemented in the PACU	Instrument developed through input from peri-operative providers; checklist items related to anesthesia were: medical and surgical histories, allergies, baseline vital signs height and weight, laboratory results, regional anesthesia, invasive monitoring, venous access, fluids, paralytics, narcotic totals, antibiotics and paralytic status; surgical and OR nursing checklists included	Category 3
Postestio et al. (2015)[12]	Observational, interventional	22 anesthesiology residents; 50 postoperative handovers in the control group;	Large teaching hospital in Washington DC	To design a succinct, user friendly handover checklist to determine if the checklist increased meaningful communication during transfers of patients	17- point checklist organized into three sections: patient procedure and medication; included a closed loop communication question to allow providers to allow to address two way communication between AP and PACU nurse	Category 3
Robins and Dai (2015)[13]	Randomized controlled	Anesthesia providers were randomized conduct the handover with or without the formulated	Adult PACU setting	To determine whether utilization of a formulated checklist decreases information loss, improves	Checklist created through input from PACU nurses, CRNAs and safety committee; instrument assessed	Category 1

		checklist; PACU nurses completed a data collection sheet to assess the handover. A priori power analysis was performed; 60 anesthesia providers (30 anesthesia providers performed handover with checklist, 30 anesthesia providers performed handover without checklist,		adequacy of the handoff, decreases the need for information clarification and decreases time spent in transfer of care Purpose: to design determine whether a POH instrument increases the transfer of information	readiness for report, patient identifying information, medical history information, type of anesthesia including airway management, antibiotics, vascular access, intraoperative course, postoperative course, opportunity for clarification, and ending the handoff	
Salzwedel et al. (2013)[14]	Prospective, pre/post intervention	Total of 120 PACU patient handovers recorded, 40 handovers using the checklist; Anesthesiologist to PACU nurse	PACU of the University Hospital	To develop a postoperative handover checklist and determine if the instrument would increase the amount of information transferred during patient handover	Tool developed through observation videotaping of residents handover to PACU nurses, Phase II introduction and implementation of tool, Phase III: videotaping of handover with and without the tool	Category 1
Siddiqui et al. (2012)[15]	Observational	Convenience sample of 5-8 sequential handovers per day selected	PACU of teaching hospital University of Toronto	To explore postoperative handover practices between anesthesiologists and PACU nurses, To determine information content of the handover Purpose: to explore and describe POH failures and problems	Checklist developed to identify communication of specific data items during the handover between anesthesiologists and PACU nursing; comprised of 4 sections, 29 items, yes/no answers: patient's pre-op physical status and demographics, intraoperative details and anesthesia management, intra-operative events and postoperative directives	Category 1
Weinger et al. (2015)[16]	Observational, multi-modal intervention including standardized electronic handover form,	Cohort of anesthesia providers AP (including residents, and certified registered nurse anesthetists	Adult and pediatric PACU	To develop a structured electronic handover and to improve interprofessional handover	Based on situation, background, assessment and recommendation (SBAR), handover communication	Category 3

	didactic webinar, simulation training	CRNA) and PACU nurses		practices through simulation training Purpose: to develop an electronic handover instrument and to develop and instrument to evaluate the eHandover instrument	and a global rating of handover effectiveness	
Wright (2013)[17]	Non-experimental exploratory/ interventional	Exploratory phase: 302 CRNAs were surveyed; Evaluation of PATIENT tool 30 CRNAs evaluated the tool by survey	1 large teaching hospital; 2 community hospitals	To examine post-operative handover practices; to develop, implement, and evaluate a communication checklist; to improve the quality of postoperative handovers	PATIENT transfer of care checklist tool; P= procedure, patient, position; A=anesthesia, antibiotic, airway, allergies; T=temperature; I=IV, invasive lines; E= $ETCO_2$, N=narcotics; T=twitches	Category 2

N/A= not addressed in the study; theoretical frameworks were not identified in the studies

Level of evidence appraisal

The levels of evidence of retrieved studies were classified into one of four categories, as proposed by Wong et al.[24] (Table 2). The fifth category proposed by Wong et al., which is published reports, was not applicable to classify studies included in this review. The categories constructed by Wong et al. were designed to enable the reader to differentiate between different types of intervention based studies, including pre and post intervention. Observational studies were also classified based on the categories.

Table 2 Wong et al.'s classification of intervention based PIT studies

Category 1	Comprehensive Intervention based study	Clear articulation of entire approach to improve clinical handover covering data collection, intervention design, implementation and evaluation and insights into lessons learned. High level of potential transferability.
Category 2	Intervention based study	Approach to clinical handover improvement intervention not comprehensive or limited in depth/clarity in published study. Medium to Low level of potential transferability.
Category 3	Pre-intervention study	Studies variously engaging in data collection, analysis and evaluation to investigate different aspects of clinical handover. Focused on: enhancing understanding, identifying issues/gaps/challenges or the utility of particular research approaches. Some studies provide recommendations for change management, handover improvement interventions or system reform. High to Low level of potential transferability of pre-intervention approaches.
Category 4	Published opinions or reviews	Publications not involving any primary research often non-peer-reviewed. Can provide potentially useful insights/perspectives on different aspects of clinical handover including high risk scenarios, evidence gaps, and factors imposing limitations on sustainability/transferability of handover initiatives.

Results

Synthesis of findings was classified based on the three dimensions of the DCM followed by sub-classification of studies based on the instrument's purpose. There were instances where the PIT instrument could be classified based on more than one dimension of the DCM. Instruments that were not formally named by the author were referred to by using the primary author's last name. A detailed description of the instruments is displayed Table 1.

Structure of PITS

Standardized communication

Applying the DCM to PITS, structure refers to the information content of PITS and frameworks to standardize information transfers. The development of standardized instruments was a common theme in the literature. Synthesis of studies describing these instruments focuses on the information content of the instrument and incorporation and of the instrument into clinical practice for the purposes of reorganizing the structure of PITS.

Wright et al. surveyed CRNAs to gain a better understanding current PIT practices, identify critical information content, and to assess the need for a standardized perioperative transfer tool.[9] Based on results from their survey, the authors developed and pilot tested the PATIENT checklist tool during PITS. Table 1 displays a description of each parameter of the PATIENT checklist tool which was communicated during PITS.[9] After implementing the PATIENT tool into PITS, CRNAs who used the tool were invited to evaluate its usefulness.

Ninety percent of CRNAs who used the tool believed the length and scope of content were appropriate. All respondents indicated the tool provided an effective way to organize PITS.[9]

Potestio et al. designed a 17 item instrument, which was divided into patient, procedure and medication sections, to guide anesthesiology residents through PITS.[25] Baseline data were collected by observing PITS prior to implementing the instrument. After implementing the instrument, anesthesiology residents communicated eight items significantly more when compared to residents who did not implement the instrument. Residents who implemented the instrument spent a significantly longer time in the PACU when compared to the control group.

Robins and Dai created an instrument with input from PACU nurses, CRNAs and members of the patient safety committee.[26] The instrument was divided into six sections: patient identifying information, medical history, type of anesthesia, intraoperative course, and postoperative information. In their randomized study, anesthesia providers were assigned either to the control group, which performed the handover without the instrument, or to the study group which performed the handover with the instrument. Outcome measures included the PACU nurse's' ability to recall key elements of the handover, handover satisfaction assessed by the PACU nurse and the rate of PACU nurse initiated callbacks for clarification of handover information. The use of the

checklist by anesthesia providers in the study group lowered the rate of callbacks and led to higher satisfaction among PACU nurses with the structured handover.[26]

Salzwedel et al., sought to determine if there was a significant difference in the amount of information transferred between the anesthesia provider and PACU nurse with and without implementing a PIT checklist.[1] The final 37-item instrument was divided into three categories: pre-operative (pre-operative risk factors, present surgical illness and surgical procedure), intraoperative (airway management, type of anesthesia hemodynamics and surgery related problems), and postoperative management (antibiotic management, post-operative investigations and availability of blood products). PITS were video recorded prior to implementing the instrument. After implementing the instrument, 40 handovers were randomized to the control group and 40 handovers were randomized to the study group which used the instrument during PITS. All handovers eligible for the study were video recorded and evaluated by independent observers using a score sheet with content items equal to the instrument. While the overall percentage of items communicated during the PITS increased significantly with implementing the standardized instrument, communication of individual items, such as ‘name’ and ‘type of anesthesia,’ showed no significant difference. PITS took significantly longer when the

instrument was used during the handover when compared to handovers without the checklist.[1]

In their multi-modal intervention based study, Weinger et al. developed *eHandover*, a standardized electronic PIT instrument organized into the Situation-Background-Assessment-Recommendation (SBAR) format.[27] The *eHandover* was divided into the four sections of the SBAR format. The first section was comprised of patient demographic information, type of surgery and anesthesia, medical history, preoperative vital signs and airway management. The second section detailed medication administration, intraoperative and postoperative vital signs, fluid intake and outputs, and intra-operative laboratory results. Intra-operative events, complications, special precautions and postoperative directives comprised the final two sections. When the surgeon was closing, the circulating nurse clicked on "*surgeon closing"* which was found in a peri-operative electronic documentation system, and the *eHandover* printed in the PACU.[27]

Gilliken et al. implemented an Electronic Patient Care Transfer Tool contained within the electronic anesthesia record and compared information omissions and deficiencies prior to and after implementation. Information recorded within the tool included patient demographics, medical history, surgical procedure, airway/intubation, intraoperative events, hemodynamic status, medications, fluid status, laboratory values and anticipatory guidance.[28] PIT

were observed prior to and after introduction of the tool. Information omissions were significantly reduced after introduction of the tool in the following information categories: patient name, allergies, medical history, surgical procedure, airway, intraoperative events, hemodynamic status, medications, fluid status, and anticipatory guidance.[28]

Process of PITS

Failure Modes and Effect Analysis (FMEA)

Content for two PIT instruments was developed through Failure Mode Effect Analysis (FMEA). Nagpal et al. developed The Postoperative Handover Assessment Tool (PoHAT) using Failure Mode and Effect Analysis (FMEA) to prospectively detect latent PIT process errors and address potential process failures before they lead to adverse events.[11] PoHAT was designed to assist clinicians in evaluating the quality and efficiency of PITS.[11] The final instrument consisted of 24 information items that were subdivided into patient information, anesthetic and surgical information categories. PITS were observed by trained researchers who rated the quality of PITS using items on the PoHAT that were completed by indicating “yes” or “no” during the observation. Eight task items were identified and included patient and equipment tasks, while teamwork was evaluated based on the following five behavioral components and rated on a 7 point Likert scale: communication coordination, cooperation, situational

awareness, and leadership. Evaluation of PITS at two study sites using PoHAT revealed a median of 8 information omissions per handover.[11]

Nagpal et al. mapped information transfer and communication (ITC) failures across the surgical pathway to develop and conduct feasibility testing of a framework to analyze communication within the perioperative setting.[14] In addition to interviews and review of pre-existing PITS guidelines, Healthcare Failure Mode and Effect Analysis (HFMEA) were used to develop the framework. The framework created structure for the following four distinct phases, which coincided with patient care across the surgical pathway: pre-operative assessment and optimization, pre-procedural teamwork, post-operative handover, and daily ward care. Further, the PITS phase was subdivided into three categories: patient-specific information, surgical procedure-specific information, and anesthesia procedure-specific information. PITS were observed, and the quality of patient-specific information communicated during the PITS between providers was compared against the patient-specific category.[14]

Petrovic et al. designed the Perioperative Handoff Protocol to standardize perioperative handovers by delineating a five-step process. All team members, including the anesthesia provider, surgeon or designee, OR nurse and PACU nurse were required to be present at the time of the handoff report.[29] The anesthesia provider initiated the PITS, followed by the nurse re-establishing monitoring technology, the surgeon communicating the surgical report, followed

by the anesthesia and OR nurse reporting and the PITS concluded after the PACU nurse clarified remaining issues. The anesthesia component of the protocol included preoperative, intraoperative and postoperative guidance.[29] In a later prospective, unblinded study, Petrovic et al. implemented the protocol during PITS between the OR and the PACU.[30] When compared to the pre-implementation group, the average number of information omissions and technical defects was significantly less ($p<.01$).

Influence of behaviors and teamwork

In the context of PITS, the *process* dimension of the DCM refers to the tasks or activities necessary to safely and effectively complete a PITS. Processes related to PITS are directly affected by *who* participates in PITS as well as *when* (i.e. timing) PITS are conducted. Investigating the influence of technical and nontechnical skills as well as the teamwork behaviors of surgical teams guided the development of two instruments. Mazzocco et al. aimed to determine if patients of surgical teams who exhibited strong teamwork had superior outcomes when compared to patients of teams with poor teamwork. Using an instrument adapted from another study, registered nurses (RN) observed and assessed surgical teams for six behavior domains including briefing, information sharing, inquiry, assertion, vigilance and awareness, and contingency management. Results revealed that patients whose surgical teams exhibited poor teamwork behaviors were at higher risk for poor outcomes.[31]

Nagpal et al. developed the Postoperative Handover Assessment Tool (PoHAT) to assess the quality and efficiency of PITS (see description of PoHAT above).[11] The teamwork component of the instrument consisted of 5 behavioral components: communication, coordination, cooperation, situational awareness, and leadership.

Closing the communication loop

One unique feature of three instruments identified in this review was inclusion of a *closing the communication loop* item.[25] Potestio et al. included a "closed loop communication" item to address interpersonal communication between the AP and PACU nurse.[25] At the conclusion of the PITS, the anesthesia provider queried the PACU nurse by asking "*Do you have any questions or concerns?"*.[25] Petrovic et al. designed an instrument for conducting peri-operative handovers that encompassed OR to ICU/PACU PITS and guided surgical and nursing reports.[29] The comprehensive instrument prompted handover team members to remain at the patient's bedside during the PITS. At the end of the handover, the receiving PACU nurse prompted team members to clarify unresolved issues and formally concluded the handover with an ending statement.[29] Manser et al. developed and tested a 19-item handover rating tool to determine components of a quality and effective handover.[15] The study hypothesized the items included in the rating tool would predict clinicians' and human factors observers' perceptions of the quality of handovers from AP to

PACU nurses. Three factors--information transfers, shared understanding, and working atmosphere--accounted for approximately 50% of the variance in the items. Shared understanding was defined as “closing the communication loop between providers,” clarifying questions, and establishing a mutual understanding of the information transferred between providers.

Anticipatory guidance

Anticipatory guidance is information given by AP to receiving PACU nurses to assist PACU nurses with managing impending and potential changes in patient status.[32] Several instruments included sections to guide post-operative care, offer contingency planning, and provide anticipatory guidance during and after the PITS. Petrovic et al. developed the OR to ICU/PACU protocol which incorporated anticipatory guidance statements communicated from the surgical and anesthesia teams to the receiving PACU nurse.[29] Weinger et al.’s *eHandover* report form, which was based on the SBAR format (see full description above) ended with a recommendation section where providers could enter anticipatory planning statements.[27] Gilliken et al. included an anticipatory guidance information field on their Electronic Patient Care Transfer Tool.[28] After implementing the tool, there was a significant reduction in the number of omissions of anticipatory guiding statements.[28]

Improved outcomes

Patient outcomes

The third dimension of the DCM is *outcomes* and refers to patient outcomes. Evaluation of observed PITS through the use of instruments suggested that adverse patient outcomes were associated with lack of teamwork and failure to communicate pertinent patient information during information transfers. Mazzocco et al. found that patients of surgical teams who exhibited strong teamwork behaviors were more likely to have less frequent episodes of morbidity and mortality (see above for description of the instrument).[31] Nagpal et al. identified four transition phases across the surgical pathway after mapping information transfers and communication across the surgical pathway.[14] (see above for description of the instrument) In their study, the information transfer and communication assessment tool for surgery (ITCAS) was developed to collect data on information transfers and communication during the perioperative phase. Data were collected on adverse medical events causing unintended injury and clinical events that could have caused harm. Failure of the PITS to communicate the post-operative plan for DVT prophylaxis led to omission of drug administration. Likewise, prescribed patient blood draws not communicated during the PITS resulted in unnoticed hypokalemia and transient arrhythmias. Both adverse outcomes were linked to information transfer failures.[14]

Provider satisfaction

The degree of PACU nurse satisfaction was measured and recorded after the PITS in two studies. Nagpal et al. conducted a prospective pre and post intervention study by observing PITS prior to and after implementing the Postoperative Handover Assessment Tool (PoHAT).[33] The tool was divided into patient specific, anesthesia specific and surgical specific information sections, a task evaluation section and a teamwork assessment section which included 5 components: communication, coordination, cooperation, situational awareness, and leadership. PACU nurses rated their overall satisfaction with the PIT on a 5 point Likert scale. With implementation of the PoHAT, PACU nurses awarded 58% of the handovers a score of 5/5 compared to only 8% of the handovers prior to implementing the PoHAT.[33]

Instrument purpose

Quality evaluation of PITS

The development of PITS instruments to evaluate the quality of PITS between AP and PACU nurses and to identify failures in information transfer and communication was consistently described in the literature. In a descriptive study, Anwari surveyed PACU nurses after receiving the handover report from the AP. The survey, which was completed by PACU nurses, was divided into four subsections and included a verbal information score (VIS), a patient condition score (PCS), an anesthetist behavior score, and PACU nurse satisfaction score Table 1 for a full description of the subsections). The study

highlighted that 67% of anesthetists failed to transfer all the essential information during the transfer and that information during the PITS was not transmitted in 40% to 60% of cases.[34]

Nagpal et al. developed and validated the Postoperative Handover Assessment Tool (PoHAT) to objectively evaluate PITS and provide data for actionable feedback and future improvements.[11] The 24 item instrument was developed by triangulating research methodologies including Failure Modes and Effects Analysis (FEMA), interviews, and literature reviews. Consensus among experts was gained by using the Delphi Method, an iterative process of achieving consensus development among experts on a specific issue.[35] The final instrument included patient information, anesthetic information, surgical information, equipment tasks, patient-specific tasks, and teamwork (i.e. leadership communication, coordination, cooperation and situational awareness). Final outcome measures were information omissions, task errors and a teamwork score. A trained researcher observed PITS at two different study sites using PoHAT and compared the quality of the handover against the components of instrument. Overall, the PoHAT was effective in identifying information omissions, task errors and the quality of teamwork during PITS.[11]

Another study by Nagpal et al. developed and tested the feasibility of the Information Transfer and communication Assessment Tool for Surgery (ITCAS) framework.[14] Similar to the PoHAT, the authors utilized triangulation of research

methodologies, including Healthcare Failure Mode and Effect Analysis (HFMEA), and qualitative inquiry with healthcare professionals to develop the ITCAS. The ITCAS framework evaluated information transfer and communication failures in 22 patients undergoing major gastrointestinal surgeries. Patients were followed and observed through the preoperative, intraoperative and post-operative phases of surgery. PITS were observed and classified based on the transfer of patient-specific information, procedure-specific information and anesthesia specific information. Results indicated communication of patient information degraded from the surgical suite to the PACU.[14]

In a prospective observational study, Milby et al. analyzed information transfer during PITS by observing 798 PITS and comparing the quality of information transferred against a 59-item instrument, structured in three sections: preoperative, intraoperative and postoperative items. Subsequently, observations compared to the checklist were compared with patient information recorded in the anesthesia record. In most cases, the quantity of information transferred was largely heterogeneous and incomplete.[5] Likewise, Manser et al. developed a 19 item instrument to aid clinicians' and human factors observers' assessment of the quality of PITS from anesthesia care providers to PACU nurses. The first 16 items of the instrument assessed information transfer and teamwork on a four-point Likert scale. The remaining items addressed handover quality and the impact of PACU environmental influences on PITS.[15] Three

factors, information transfer, shared understanding and working environment, were identified to assess quality across PITS observations.

The postoperative handover protocol (POP) was developed after qualitatively identifying information transfer and communication (ITC) failures in the PITS process.[7] Eighteen health care providers including surgeons, anesthetists and nurses were queried to explore and describe failures in ITC and offer solutions to reduce in ITC failures. The final POP was a 21-item instrument organized under the following headings: patient-specific information, surgical information and anesthetic information. When operationalized into practice, the POP was designed to serve as checklist for PITS.[7] After implementing the POP in a subsequent study, Nagpal et al. found patient and equipment-specific task errors were reduced significantly while teamwork (i.e. leadership, communication, situational awareness) improved significantly.[11]

Siddiqui et al. developed an instrument to identify information omissions during PITS.[36] Items included on the instrument were identified from the anesthesia record, a literature review and were finalized using the Delphi Method to gain consensus among anesthesiologist contributors. The 29-item checklist comprised four sections: preoperative and patient demographic information, anesthesia management and intraoperative information, significant intra-operative events and postoperative directives. PITS were observed by a single observer and the verbal content of the handover was compared against the data

items on the instrument. Items were coded “yes” or “no”, indicating whether an item was communicated. Items were coded “not applicable” if an item was neither present, meaning the event did not occur such as a difficult intubation, or the event was not communicated. Items not communicated in 88% or greater of the PITS were patient positioning, the American Society of Anesthesiologists’ (ASA) classification, and estimated blood loss. The only items communicated in over 90% of the PITS were type of surgery and intraoperative analgesia. At the conclusion of the observation period, anesthesiologists were surveyed and agreed that coexisting medical diseases, patient allergies, type of surgery and degree of difficulty with intubation need to be communicated during PITS. PACU nurses agreed 17 of the 29 items needed to be communicated during PITS. In addition to items identified by anesthesiologists, PACU nurses felt ST segment changes, hypothermia, urine output, analgesics and types of intravenous access should be reported during PITS.

Weinger et al. hypothesized the introduction of a multi-modal intervention that included an electronic PITS instrument, the *eHandover,* didactic webinar, simulation training and post-simulation training feedback would improve the overall quality of PITS.[27] To assess the impact of implementing the *eHandover,* research nurses who were not involved in the study observed and rated the PITS using the Post-Anesthesia Handover Evaluation Tool (PAHET). The PAHET was organized into the following major sections: introduction, readiness for report,

elements of handover information based on the situation-background-assessment-recommendation (SBAR) format, handover communication and a global rating of handover effectiveness. Handover communication was subdivided into content and organization, completeness of content, confirming comprehension, level of engagement and coordination and conflict resolution. After implementing the *eHandover,* the observers' ratings of PITS indicated the proportion of acceptable handovers increased significantly from 7% to 70%? (95% CI, 3%-17%) from the baseline to the post implementation phase.

Discussion

The majority of instruments identified in this review were designed to: standardize information transfers between anesthesia providers and PACU nurses. evaluate processes related to PITS, or evaluate the quality of PITS. Instruments developed to standardize the structure of PITS demonstrated increases in the amount of critical information transferred during PITS, decreases in information omissions, and decreases in both high risk events and task errors.[1,26–31] Studies that addressed two or more dimensions of the DCM demonstrated similar positive results when compared to instruments that addressed one dimension. Instruments that were tested at more than one study site demonstrated similar positive results when compared to instruments tested at a single study site. Mazzocco et al., Nagpal et al., and Weinger et al. conducted their studies at two or more sites and had similar positive and

significant results.[11,27,31] Assessing the impact of PITS instruments and behaviors of surgical teams at more than one study site could increase the generalizability of the results to other practice settings.

An important gap in the body of evidence related to PITS was a lack of studies that assessed patient outcomes after implementing PITS instruments. A majority of the studies measured communication of specific content items, teamwork, duration of PITS, and provider satisfaction.[1,11,27–30] Healthcare is shifting its focus from the volume of care delivered to patients to the value of care delivered to patients, where value is defined as patient outcomes relative to healthcare cost.[37] Because of this shift, evidence-based practice and research related to PITS should be directed toward clinically important outcomes that directly affect patient morbidity and mortality.[6] Designing studies that link relationships between the quality of PITS and patient outcomes would allow researchers to demonstrate the impact of poor quality PITS on morbidity and mortality. The goal of successful PITS is to safely and reliably transfer the care of vulnerable patients from the anesthesia provider to the receiving team. In designing future studies, it will be prudent to drill down and measure patient specific parameters, such as the incidence of re-intubations in the PACU, and assess for potential linkages of such events to communication of information directly related to airway management and arterial blood gases. While this review identified several instruments in extant literature that were developed to

standardize the structure of PITS,[1,27,28,30] only two studies explicitly investigated behavioral and environmental factors influencing PITS. Evidence to support the importance of teamwork and concise communication of peri-operative patient information during PITS was identified in two studies.[15,31] Teamwork, adaptability, integration and environmental characteristics were shown to be important factors that influence the quality of PITS and patient outcomes.[15,31] Mazzocco et al. found that morbidity and mortality was higher among patients whose surgical teams exhibited less teamwork behaviors. [31] Deficits in teamwork and interpersonal communication among providers may lead to unsuccessful implementation of standardized PIT procedures.[38] Further, the dynamics of peri-operative team communication and behaviors during PITS could serve as barriers to implementing even the highest quality PIT instrument. Sociological challenges, such as hierarchy, perceived importance of the PITS, and power imbalances can undermine the process of implementing standardized PIT practices.[38] Integration of multi-modal approaches to improving the structures, processes, and outcomes of PITS is more likely to create a milieu where structured PIT instruments can be successful.[38]

Two studies described implementation of electronic PIT instruments.[27,28] Implementation of electronic health records, including electronic anesthesia information management systems (AIMS), has gained momentum over the last decade.[39] In 2009, The Health Information Technology for Economic and Clinical

Health Act laid the foundation for growth in the use of electronic health records by incentivizing health care institutions who adopted electronic health records.[40] Potential advantages of implementing AIMS include improved patient safety, quality of care and enhanced exchange of complex health information.[39] Additional research is needed to investigate the impact of AIMS, including electronic PIT instruments, on clinical outcomes. Any of the reviewed instruments can be adapted to meet the local needs of providers. The question then becomes, "how does an investigator or clinician choose the right instrument?" The type of instrument an investigator or clinician chooses depends on the intended use, the type of information desired, and the goals for improving the PITS. For instance, if the goal is to improve the quality of information transferred, meaning ensuring critical patient information points are communicated during PITS, then an instrument that addresses the structure of PITS should be selected. Tailoring one or more of the aforementioned instruments offers an alternative to selecting a single existing instrument.

Prior to standardizing PIT, systematic evaluation and assessment of current PIT practices is essential. Qualitative assessment of current PIT practices can be performed by conducting key informant interviews and through observational methods. After identifying gaps in current PIT practices, goal-directed strategies can be developed. It is, however, important to go one step further to evaluate the effectiveness of planned interventions. Points to consider

when evaluating the effectiveness of goal directed PIT interventions include evaluating feasibility outcomes such as usability, sustainability, and transferability.

If a department seeks to implement a standardized PIT protocol, several steps should be undertaken before selecting an instrument. Selection of an instrument will be influenced by the patient population, information needs of the providers, and environmental factors. Because PITS are multifaceted and influenced by individual, interpersonal, and environmental factors, an understanding of PIT may require a broader and more comprehensive approach rather than focusing on one aspect of PITS. Weinger et al. developed a successful multi-modal approach to investigate PITS. In their study, providers were introduced to a standardized handover protocol, attended a didactic webinar, and participated in PIT scenarios developed to prepare providers for a variety of PIT processes. Likewise, providers were periodically given feedback about the effectiveness of their PIT. One reason for the success of this study may be that providers were engaged on multiple learning and orientation levels. Continuous education and training throughout the process of introducing a new PIT instrument proved to be beneficial to the success of the study.[27] While standardized instruments have been shown to significantly reduce information omissions during PITS,[33] we acknowledge a standardized instrument may have limitations. Napgal et al. points out that standardized instruments may remove

the informal nature of interpersonal communication which is essential to establish shared understanding among providers.[7] Likewise, “scripting” information transfers removes opportunities for prioritizing and communicating the most pertinent information first.[7]

One of the strengths of the instruments described in this review was utilization of processes associated with participatory action research (PAR) in eight studies to determine the structure and outline the processes of PITS, as well as to identify critical patient outcomes.[1,7,11,14,26,27,29,36] The studies utilized a variety of provider engagement strategies, including conducting semi-structured interviews and focus groups with key stakeholders. While conducting semi-structured interviews was one way to determine the information needs of providers during PITS, one of the studies explicitly stated individual interviews were conducted with providers to determine information needs. When feasible, investigators may elicit more in-depth information when providers are interviewed individually. Some providers may feel uncomfortable or intimidated in group settings and may choose to share less information without the confidentiality of an interview or anonymous input mechanism.

The value in engaging key stakeholders, including AP, PICU, and PACU nurses, surgeons, and residents, is that these providers become actively involved in developing the instrument from its inception.[41,42] Providers who routinely participate in PITS have valuable insight into information needs during this critical

time of transition. Involving key stakeholders and providers early in the development of PIT instruments increases the usability and sustainability of the interventions. Likewise, providers are more likely to implement instruments that they were actively involved in developing.[41,42] Ultimately, the goal of PIT is to ensure patient safety during the vulnerable handover process. Incorporating the priorities of various providers who participate in PITS ideally results in more comprehensive information transfer episodes.

Conducting failure mode effects analysis (FMEA) offered a valuable approach to analyzing PITS. Through FMEA, high risk, vulnerable areas can be identified. Once identified, those high-risk areas can be evaluated for process changes and corrective measures.[43] A benefit of the FMEA approach is its ability to "foresee" potential failures and deficits in PITS and to address those deficits, in theory, before patient safety is compromised. To conduct FMEA and for other quality improvement purposes, simulator training may be an effective approach to identifying high risk areas during PITS. Developing high-risk simulation scenarios in which interpersonal communication is compromised presents a model where potential failures may be identified when patient safety isn't compromised.[27] By consulting anesthesia providers and PACU nurses, a systematic approach to identifying "near miss" scenarios could be identified and studied in simulation.

Limitations

A single researcher (MR, the first author) completed the literature search, data extraction and synthesis of studies identified in this review and no reliability measures were performed. The search strategy may have failed to identify all relevant studies. Important to note is that handovers take place in other practice settings, such as in the emergency department and between hospitalists during shift changes. There may be similarities and differences between handovers conducted in other practice settings that could be used to inform quality improvement initiatives in PITS. Thus, inclusion of studies exploring handovers conducted in other anesthesia practice settings could yield additional adaptable instruments. Likewise, PITS in pediatric and cardiac anesthesia settings were not included in this review. Article selection was limited to PITS between anesthesia providers and PACU nurses. The review acknowledges PITS also occur between anesthesia providers and ICU nurses in intensive care unit settings. Studies included were limited to those written in English; therefore, selection bias may have occurred and relevant studies published in other languages may have been omitted. Because PITS are influenced by individual, interpersonal and organizational factors, it was challenging to classify each instrument into one dimension of the DCM. Likewise, there was overlap when classifying the purpose of the instrument and subsequently classifying instruments based on the DCM. Results of this review indicate PIT instruments

were developed with the purposes of evaluating and improving the structure, process or outcomes of PITS.

Future Research

The studies described in this review suggest that future research should focus on not only the structures of PITS but also the processes involved with PITS. Likewise, measurable patient outcomes should be identified and incorporated into the development of PIT instruments. PIT research would benefit from development of additional multi-modal interventions to address the structures, processes and outcomes of PITS. Future research should utilize PAR to: identify information transfer deficits, identify barriers and facilitators to PITS, and to design context specific, user-friendly PIT instruments. To increase the rigor of future studies, PITS should be randomized to a study group, which implements a PIT instrument, and to a control group. Then, patient outcomes can be compared between the study and control groups. This review identified only two studies where anesthesia providers were to a control group, which conducted PITS without instruments, or to study groups who conducted PITS using an instrument.[1,26]

Conclusion

While it has been established in the literature that standardizing PITS improves quality, arbitrary selection of a PIT instrument should be avoided. Purposeful selection of a PIT instrument should follow a systematic process that

begins with identification of core deficits by consulting with key stakeholders. The multi-modal research design proposed by Weinger et al. offers a logical and systematic approach to standardizing PITS because the design integrates the structure, processes, and outcomes of PITS.[27] We recommend referencing Segall et al.'s systematic review of post-operative handover literature to identify recommendations for information content.[2] Likewise, the research design could be scaled down to conserve costs and time associated with developing and implementing a new instrument. Importantly, the research design is comprehensive and engages anesthesia providers and PACU nurses whose input is critical when discovering what works best to improve a complex care event.

Funding: MR received the Doctoral Fellowship from the American Association of Nurse Anesthetists and the AORN/CCI PhD grant.

Acknowledgements: Susan Newman, PhD, Director of the PhD in Nursing Science Program, Medical University of South Carolina; Tom G. Smith, PhD, Center for Academic Excellence/Writing Center, Medical University of South Carolina

Conflicts of interest: The author has no conflicts of interest to disclose.

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Manuscript III

Improving post-operative information transfers: Evaluating patient outcomes

Abstract

Purpose: The purpose of this study was to pilot test and assesses the feasibility and acceptability of the electronic postoperative handover information transfer instrument (EPITI).

Design: A sequential exploratory mixed methods design was chosen to collect qualitative and quantitative data analyze the data separately and merge the results to assess the feasibility of the EPITI.

Methods: Guided by a participatory research approach (PAR), a 3-phase study was implemented to develop and evaluate an EPITI. During Phase I, focus groups were held with key stakeholders, including anesthesia providers (AP) and post-anesthesia care unit (PACU) nurses, to tailor the information content and inform processes related to pilot implementation of the EPITI. During Phase II the EPITI was pilot tested in the main PACU of a tertiary level hospital for 60 postoperative information transfers (PITS). Using qualitatively and quantitatively methods, Phase III of the study evaluated the feasibility of the EPITI by conducting key informant focus groups and semi-structured interviews with key stakeholders who also completed a feasibility survey. The PACU length of stay

of patients was measured in minutes and compared between similar patients prior to and during pilot testing the EPITI. Categorical pain scores on arrival to PACU, where PACU nurses indicated if patients who entered the PACU had pain scores were >5 on arrival to PACU by circling “yes” or “no” on a quality indicator form, and completion of PACU orders were compared and reported as odds ratios for the aggregate groups of patients prior to and during pilot testing the EPITI.

Results: Twelve (N=12) AP and five (N=5) PACU nurses pilot tested the EPITI for a cumulative total of 60 PITS. In general, AP and PACU nurses endorsed the feasibility and acceptability of the EPITI. Opportunities for improvement included: provider training prior to pilot testing the EPITI, computer or smart device availability in the PACU, accessing the EPITI and expansion of information fields to include explanatory fields, and integration of the EPITI into the electronic health record. After matching similar cases prior to and during pilot testing the EPITI, there was no significant difference between groups for the outcome variable PACU length of stay. Pain scores on arrival to PACU and the number of completed PACU orders varied significantly between the pre and post pilot test groups.

Conclusion:

Recognizing the multidimensional nature of post-operative information transfers, the benefits of standardizing information transfers and the value of

PAR, results of this study demonstrated the EPITI was feasible when implemented into practice, accepted by AP and PACU nurses and integrated well into clinical practice. The EPITI was received well among AP and PACU nurses, but there remain logistical barriers to full implementation and uptake. Verbal information transfers have well recognized weaknesses. The EPITI compensates those weaknesses when information transfers utilizing the EPITI serve as an audit point and opportunity for review and discussion of data obtained from other parts of the patient electronic health record. Future research should evaluate the impact of implementing electronic handover forms on patient outcomes.

Introduction/Background

In 2001, The Institute of Medicine (IOM) issued the pivotal statement that inadequate patient handovers are "where safety often fails first."[1] Following this statement, the Joint Commission's "2006 National Patient Safety Goals" proposed the patient safety standard that all health care providers implement a standardized approach to postoperative handovers, the transfer of patients from the operating room to post-operative care.[2] Furthermore, the Joint Commission estimated that communication errors during patient handovers account for 80% of medical errors.[3] Failure to transfer critical pieces of information are associated with delays and errors in treatments, increased length of stay, and, potentially, increased morbidity and mortality.[4]

Handovers, are defined as "the transfer of professional responsibility and accountability for some or all aspects of care for a patient or group of patients to another person or professional group on a temporary or permanent basis".[1(pg.1)] In the post-operative environment, handovers involve the transfer of patient information and care between the anesthesia provider (AP) and the post-anesthesia care unit (PACU) nurse. Unlike other clinical areas, transferring patients from one provider to another in the PACU environment involves cross-disciplinary staff with different perceptions and expectations of what information should be communicated.[5,6] Instead of co-orienting providers with the patient's status, post-operative information transfers (PITS) often involve unidirectional

transfer of information from the AP to the PACU nurse who has limited time to integrate and prioritize information.[5,7] Because of numerous transition points in care, surgical patients are particularly vulnerable to communication errors.[8] Moreover, the PACU environment has been described as being event driven and time pressed, making PITS even more challenging.[5,7] AP and PACU nurses must reestablish monitoring technology while maintaining vigilance over patients who are under the influence of anesthesia. Therefore, pertinent information must be communicated seamlessly to promote continuity of care and patient safety.

Failed or ineffective PITS can affect immediate and long term recovery of post-surgical patients.[9] Prior research has described PITS as being prone to technical and communication errors,[8,10] such as information omissions, which can lead to delayed initiation of prescribed treatments, wrong treatments, preventable adverse events, increased length of stay and potentially increased morbidity and mortality.[7,9,11] The Joint Commission's 2006 National Patient Safety Goals required that all health care providers (institutions) implement a standardized approach to transitions in care, including PITS. In 2009, The Health Information Technology for Economic and Clinical Health (HITECH) Act laid the foundation for adoption of electronic health records (EHRs) by providing financial incentives to health care institutions who adopted EHRs.[12] As the transition to EHRs proceeds and gains momentum, health care systems are integrating anesthesia information management systems (AIMS) to facilitate peri-

operative patient transitions. Potential advantages of implementing electronic AIMS include improved patient safety, quality of care, and enhanced exchange of complex health information.[13]

Few studies have been conducted to evaluate electronic handover (PIT) instruments in post-operative care transitions. Jayaswal and colleagues developed and pilot tested a mandatory handoff protocol embedded within their electronic health record.[14] The study assessed provider satisfaction with current handover practices and with implementation of the electronic handover protocol.[14,15] Results of the study indicated the electronic handover provided a more useful and complete handover and improved patient care.[14] In a similar study, Gillikin et al. found that standardizing PITS by implementing a handover tool contained in the electronic anesthesia record significantly reduced the number of information omissions.[15]

The purpose of this sequential exploratory mixed methods study was to pilot test and assesses the feasibility of an electronic post-operative information transfer instrument (EPITI). We assessed implementation of the EPITI for signal of effect on patient outcomes including PACU length of stay, completion of PACU orders and the number of pain scores >5 on arrival to PACU. Guided by a participatory action research (PAR) approach, where AP and PACU nurses were actively involved at the inception and throughout the research process,[16] the study was conducted in three phases. In Phase I, the research team worked

collaboratively with AP and PACU nurses to develop and tailor the EPITI to meet the local needs of AP and PACU nurses. Phase II involved implementing and pilot testing the EPITI during PITS between AP and PACU nurses. Phase III comprised evaluation of the feasibility and acceptability of the EPITI through focus groups with AP and PACU nurses who pilot tested the EPITI, followed by quantitative assessment using a feasibility survey. Triangulation of qualitative and quantitative results, i.e. merging in-depth perspectives obtained from focus group discussions with the results of the feasibility survey, created a comprehensive evaluation of feasibility and acceptability.[17,18] In Phase III, we assessed the EPITI for signal of effect on patient outcomes through a retrospective medical record review.

Methods

Participatory Action Research

Participatory action research is an approach to research that fosters equitable partnerships and sharing of knowledge between investigators and participants during all phases of the research study.[16] Involving key stakeholders and providers early in the development of postoperative information transfer instruments (PITS) increases the usability and sustainability of the interventions.[16,19] Historically, APs and PACU nurses from the study site, other than one anesthesiologist representative to the expert panel from our institution, were not included in developing EPITI. In response to this omission, a

participatory action research (PAR) approach was applied in the present study to gain insight from AP and PACU nurses who were key stakeholders in the postoperative transition process. A perioperative advisory board was formed to serve as an ongoing collaborator in development and evaluation of the EPITI. The board consisted of the PI, who is a CRNA, the chairman of the Department of Anesthesiology, and the Directors of Anesthesiology Technology and Perioperative Anesthesia.

Phase I: EPITI Development

Provider Input

Our PAR approach was implemented using qualitative methods, including AP and PACU nurse focus groups, to gain their insight and perspectives on the information content and implementation processes of the proposed EPITI. Following IRB approval, AP and PACU nurses were provided an example of a proposed EPITI during focus group discussions, were asked to evaluate the EPITI, and to identify additional, critical information that should be captured on the EPITI. In addition to discussion of the EPITI content, APs and PACU nurses were asked to identify perceived process and communication barriers and facilitators to incorporating the EPITI into PITS. Key findings of the focus groups were applied to tailor the EPITI using a shared-decision making process during Phase 1 of study. Our PAR approach facilitated the development of an EPITI that reflected the stakeholders' preferences for information content and implementation processes.

Tailoring the EPITI

Tailoring the EPITI prior to pilot testing involved an iterative process of member checking and seeking direct feedback from key stakeholders. Qualitative data obtained from focus group discussions was utilized to tailor the information content and implementation processes of the proposed EPITI. Once the qualitative data from the focus groups were synthesized and organized, the

PI incorporated recommendations for the information content and information transfer processes related to the EPITI. Three AP and two PACU nurses reviewed the first drafts of the EPITI prior to pilot testing. Additional information fields were added based on the information needs of AP and PACU nurses. Because this was a pilot study, ongoing revisions were made to the information content of the EPITI. One of the goals was to promote PAR by actively engaging AP and PACU nurse in the process of tailoring an instrument that both providers would incorporate into practice. On the basis of the identified information needs and practices of APs and PACU nurses, key stakeholders were engaged in a shared decision-making process to tailor the proposed EPITI. Appendix K displays the final EPITI that AP and PACU nurses pilot tested.

Phase II: Pilot Testing

After obtaining IRB approval, pilot testing the EPITI was conducted at a tertiary level hospital in Washington, DC, where approximately 20,000 inpatient and outpatient surgeries are performed annually. The Departments of Anesthesiology and Perioperative nursing employ approximately 100 APs and 45 PACU nurses.

Recruitment of participants

Using a purposive sampling approach, we applied *a priori* inclusion and exclusion criteria to select AP and PACU nurses to participate in pilot testing the EPITI. Inclusion criteria included providers who worked full-time, defined as 40

hours per work week during the hours 0700-1900, worked primarily in the main PACU on the ground floor, and included anesthesiologists, certified registered nurse anesthetists (CRNAs) and anesthesiologist assistants (AAs). AP and PACU nurses who worked part-time, per diem or at night defined as 1900-0700 were excluded. Likewise, AP and PACU nurses who were in orientation, and worked primarily in the gastrointestinal lab (GI), outpatient setting, electrophysiology lab, cardiac and obstetrical anesthesia were excluded.

Purposive sampling, the deliberate selection of individuals who are knowledgeable about or experienced with a phenomenon of interest, facilitated recruitment of AP and PACU nurse participants who were knowledgeable about PITS. Once eligible APs and PACU nurses were identified, invitations were emailed to providers to recruit participants to pilot test the EPITI (See Appendix L for the invitation). Additionally, recruitment occurred during staff meetings and PACU nurse change of shift huddles. AP and PACU nurses who were interested in participating in the pilot study were encouraged to contact the PI directly. Once APs and PACU nurses were identified who expressed interest in pilot testing and assessing feasibility of the EPITI, two lists of interested providers, one list for APs and one list for PACU nurses, were generated. Additional AP and PACU nurses were recruited, as needed, to participate in pilot testing and assessing the feasibility of the EPITI.

EPITI Implementation

The EPITI was pilot tested by a purposively selected group of AP and PACU nurses who were involved in the transfer of care of patients from the main operating room to the PACU. One of the goals was to pilot test the EPITI with a select group of AP and PACU nurses among a wide variety of surgical cases. All cases were general anesthesia cases where the inhalation agent was administered via an endotracheal tube or laryngeal mask airway. The following surgery types were excluded from pilot testing as they require a highly specialized recovery area and regime: electrophysiology lab (EP), gastrointestinal lab (GI), and cardiac surgical cases. Likewise, plastic surgery cases were excluded because these surgical cases take place outside the main operating room. Surgical cases where regional anesthesia was the primary anesthetic were also excluded.

The pilot EPITI form was created and implemented electronically by using REDCap (research electronic data capture), which is a secure, web based application that provided a customizable platform to enter patient information. Patient, preoperative, intraoperative, and postoperative information, collectively referred to as peri-operative information, were entered into 84 EPITI records by the AP or the PI. Pilot testing of the EPITI was carried out by entering perioperative information into the EPITI during surgical procedures, saving the information entered into the form, then accessing the EPITI when the AP entered

the PACU. Post-operative information transfers (PITS) were carried out between the AP and PACU nurse, while both providers referenced the EPITI.

Phase III: Evaluation

Provider Evaluation of Feasibility

Qualitative*.*

The qualitative component of this mixed methods evaluation included conducting focus groups and individual interviews with AP and PACU nurses who pilot tested the EPITI. The purpose of the focus groups and semi-structured interviews was to explore and describe AP and PACU nurses' experiences with pilot testing the EPITI. AP and PACU nurses were asked to qualitatively evaluate the feasibility and acceptability of implementing the EPITI and to determine if providers were partial to implementing the EPITI.

Recruitment and inclusion criteria

Purposive recruitment was conducted by emailing a focus group invitation (See Appendix M) and a doodle.com scheduling link to AP and PACU nurses who pilot tested the EPITI.

Participants in the focus groups

AP focus group: The AP focus groups were comprised of certified registered nurse anesthetists (CRNA) and anesthesiologist assistants (AA). The anesthesiologist (MDA) who pilot tested the EPITI preferred to write responses to focus group questions. Three focus groups were conducted by the PI. Two APs

were interviewed individually by the PI due to scheduling conflicts. Combined, there were five interactions with AP. Each focus group lasted approximately 40 minutes and was conducted in a private conference room at the study site.

PACU nurse focus group: The PACU nurse focus group was comprised of two nurses and was conducted by the PI. One individual interview was conducted by the PI. Combined there were four interactions with PACU nurses. Two PACU nurses agreed to provide written answers to focus group questions. Each focus group and individual interview lasted approximately 40 minutes.

Data collection

Focus group discussions were guided by a five-question interview guide designed to elicit participants' experiences with pilot testing the EPITI (See Appendix N). Our interview guide was based on the following focus areas of feasibility studies proposed by Bowen et al.: acceptability, practicality, and integration of the EPITI.[20] For example, one question on the interview guide was designed to assess the level of burden providers experienced when pilot testing the EPITI. Interview guide questions were framed to determine how PITS were improved when the EPITI was implemented and to explore instances when implementing the EPITI was burdensome. Likewise, questions were developed to explore and describe communication between AP and PACU nurses and to identify operational issues with implementing the EPITI. Because this study was the first departmental study to pilot test an electronic information transfer form,

process and resource assessments were performed. APs and PACU nurses were encouraged to openly and freely discuss their experiences with pilot testing the EPITI. The context of the focus groups and semi-structured interviews promoted conversational, relaxed and friendly communication.[21] Data collection for the semi-structured interview followed the data collection procedures of the focus groups. The PI moderated all focus groups and digitally recorded discussions on a password protected smart device. Once the audio recordings were professionally transcribed, the PI anonymized the transcriptions and compared them to original audio recordings for accuracy.

Data analysis

Methods of deductive, qualitative content analysis were used to analyze data from focus groups and semi-structured interviews. [22] Line by line coding was carried out to extract data from transcripts in the form of meaning units, the constellation of words or phrases that relate to the same central meaning,[23] which were organized into a table in a Word document based on an *a priori* coding scheme.[24–26] The three dimensions of the Donabedian Conceptual Model, structure, process and outcomes, were the primary *a priori* coding categories, while an additional category labeled *opportunities for improvement* was added for meaning units that could not be categorized based on the DCM. When applied to postoperative information transfers, *structure* is defined as the information content and organization of information in the EPITI; *process* refers

to the mechanisms, including the sequencing of events and interpersonal communication, that affect the manner in which PITS are conducted between AP and PACU nurse*; and outcomes* refer to the effect of the PITS on patient outcomes.[27,28]

A constant comparative process was applied, continuously comparing the views and experiences of AP and PACU nurses within and across focus groups and semi-structured interviews. Data analysis sought to reduce the volume of text and bring forth an understanding of provider experiences when pilot testing the EPITI.[29] The structure of data analysis was operationalized based on previous knowledge gained from the DCM evaluation of health care quality and services.[30] One of the goals during the content analysis process was to describe the textural or original meaning of the data while preserving the original meaning of the data [30].

Data were analyzed by the PI. To enhance credibility of the coding scheme, an independent qualitative researcher, not involved with any other aspects of the study, reviewed a sampling of the coding scheme developed from the AP transcripts. Results were triangulated by the PI who was knowledgeable about PITS, and by two experienced researchers who were knowledgeable about qualitative research.

***Quantitative*.**

Data Collection. Immediately following key informant focus groups or individual interviews, AP and PACU nurses were invited to participate in an electronic online feasibility survey.

Measures.

Primary feasibility outcomes, identified by Bowen et al., were selected to determine whether or not the concepts and processes related to pilot testing the EPITI are appropriate and sustainable for future research. Assessment of the following feasibility outcomes were included in the survey completed by AP and PACU nurses: acceptability, integration, timing, and level of burden [20]. Member checking with AP and PACU nurses and consulting with outside research experts revealed the following outcome measures: information content, interpersonal communication, intended use (fidelity), incidence of near misses, provider satisfaction and orientation/training. Items on feasibility outcomes were extracted and adapted from existing feasibility survey instruments.[31,32] Responses to survey questions were measured on a 7 point Likert scale ranging from strongly disagree to strongly agree. Additional member checking revealed two of the original survey questions had dichotomous meanings and required separation into four questions instead of two. AP completed a second survey to clarify their responses to two dichotomous questions on the original survey. Results of the primary survey will be reported. PACU nurses completed the survey which included the revised questions.

Data Analysis

Feasibility Survey

Because of small sample sizes in the AP group (N=12), binary coding was used to recode the Likert scale items into two levels. Principles of Davis's Technology Acceptance Model, a model used to explain and predict user behavior and technology, were incorporated to evaluate AP and PACU nurses perceived usefulness, acceptance and integration of the EPITI.[33] Scale items that ranged from *strongly agree to somewhat agree* were coded as "1" and indicated the provider's response supported or favored the feasibility of EPITI. In contrast, items ranging from neutral to strongly disagree were coded as "0" and represented unfavorable or contrasting responses to the feasibility outcome. The directionality of each survey question was considered when recoding Likert scale responses.

Statistical analyses were conducted using SPSS v.24. AP and PACU nurse feasibility survey responses were analyzed independently. On the basis of recoded Likert scale data, Chi square test of homogeneity with level of significance $p \leq 0.05$, was performed to analyze responses to the AP survey and to determine if more than 50% of AP survey responses indicated it was feasible to incorporate the EPITI into practice.

Evaluation of Postoperative Patient Outcomes

The EPITI was evaluated for signal of effect on PACU length of stay, completion of PACU orders by AP, and patients' pain scores on arrival to PACU.

PACU length of stay

One of the aims of this study was to assess the EPITI for signal of effect on the PACU length of stay through retrospective review of medical records. The length of PACU patient stay of surgical cases patients (N=60) whose AP pilot tested the EPITI was compared to length of PACU stay for similar surgical cases (N=60) three months prior to pilot testing the EPITI. Prior to statistical analysis, repeated surgical procedures were removed by combining procedures for the same patient, and sub-procedures were collapsed under major surgical headings.

Overall PACU length of stay of patients whose AP pilot tested the EPITI was compared with the PACU length of stay of patients prior to pilot testing. Timeframe 1 refers reflects PACU length of stay prior to pilot testing while timeframe 2 reflects PACU length of stay during pilot testing. Data were analyzed using the independent sample t-test with level of significance ($p \leq 0.05$) to compare the PACU length of stay between timeframes 1 & 2.

Similar surgical cases prior to and during the pilot testing phase were matched based on type of procedure, gender and age and ASA classification. Using the “Matching” package in R, cases were selected from the pre-pilot test dataset using the aforementioned criteria and matched with cases in the pilot test dataset.[34] Multiple pairs of matched cases that were equally matched were randomly selected. The outcome variable of interest for this analysis was PACU length of stay measured in minutes. Gender and type of procedure covariates were exact matches between the pre pilot test and pilot test groups. American Society of Anesthesiology (ASA) physical status classification was matched between cases within one category while age was matched varied within .66 SD (10.45 years) between pre-pilot test and pilot test cases. Based on this analysis 54 of the total 60 total pilot cases were matched with pre pilot case data based on gender, age, ASA classification and type of procedure. The matching strategies were performed to capture as many similar cases as possible between the pre-pilot test and pilot test cases. Likewise, an iterative process was used to determine the smallest range of ages to allow for the highest retention of matched cases. After performing procedures, data were analyzed by extracting

and comparing the PACU length of stay for each of the matched pair using the paired sample t-test with level of significance ($p \leq .05$).

Completion of PACU orders and pain scores on arrival to PACU

PACU nurses complete a quality indicator form when patients arrive in the PACU that indicates whether PACU orders were completed by the anesthesiologist and whether the patient's pain score on arrival to PACU is greater than five by indicating "yes" or "no" on the quality indicator form. Data collected from the quality indicator form was used to calculate the odds ratio for PACU orders and pain scores prior to and during pilot testing the EPITI.

RESULTS

Phase II

The EPITI was pilot tested during 60 postoperative information transfers by AP (n=12) and PACU nurses (n=5). Provider demographics are displayed in Table 1. The AP group was comprised of two men and 10 women. Approximately fifty- eight percent (58.3%) of the AP were White, 25% Black/African American and 16.7 % were Asian/Pacific Islander. One AP achieved post-master's education while 11 AP achieved Master's degree education. The mean age of AP was 31.83 (SD 6.45) and the mean number of years in practice was 3.67 (SD 3.34).

Table 1 Anesthesia provider and PACU nurse demographics

	Anesthesia Provider (AP)	PACU nurse
Gender (No./%)		
• Male	2 (16.67%)	2 (40%)
• Female	10 (83.33%)	3 (60%)
Race		
• White/Caucasian	7 (58.3%)	0
• Black/African American	3 (25%)	4 (80%)
• Asian/Pacific Islander	2 (16.7%)	1 (20%)
Highest level of education		
• Associate's degree	0	1 (20%)
• Bachelor's degree	0	1 (20%)

• Master's degree	1 (8.3%)	3 (60%)
• Post-master's degree	11 (91.7)	0
Years in Practice (mean/SD)	3.67 (SD 3.34).	10.80 (SD 8.79)
Mean age (years/SD)	31.83 (SD 6.45)	42.2 (SD 11.12)

Two men and three women comprised the PACU nurse group. Eighty percent (4/5) were Black/African American and 20% (1/5) was Asian/Pacific Islander. Three PACU nurses achieved Master's degree education and one PACU nurse achieved Bachelor's degree education. The mean age of PACU nurses was 42.2 (SD 11.12) and the mean number of years in practice was 10.80 (SD 8.79).

Table 2 displays the types of surgical cases for patients whose AP and PACU nurses pilot tested the EPITI. Patients were 50% male, and the mean age was 52.6 years (SD= 18.0). The majority of patients (60%) were classified as an ASA II based on the American Society of Anesthesiology (ASA) physical status classification system. Approximately 27% of patients were ASA class III, 8.3% were ASA class I and 3.3% were ASA class IV.

Table 2 Types of Surgical Cases (N=60)

Type of Surgery	Surgical Case (s)
Endocrine (n=11)	Thyroidectomy, parathyroidectomy, adrenalectomy
General (n-24)	Laparoscopic cholecystectomy, appendectomy, gastric sleeve, ventral and incisional hernia repair, pancreatectomy,, salpingo-oophorectomy
Maxillofacial (n=2)	Lefort I osteotomy
Neuro (n=4)	Lumbar laminectomy, hemicraniectomy, thoracic decompression, anterior cervical discectomy
Orthopedic (n=14)	Knee replacement, hip replacement, ankle arthroscopy, open reduction internal fixation ankle, shoulder

	arthroscopy
Urology (n=3)	Bulbar urethroplasty
Vascular (2)	angiogram

Phase III

In line with the sequential exploratory, mixed-methods design, the two connected but different strands of data were analyzed separately and the findings presented sequentially. The findings from both strands were combined at an interpretative level to generate key conclusions.[18]

Qualitative Results: Provider Evaluation of Feasibility

Based on the Donabedian Conceptual Model, the following primary themes emerged from data analysis and were classified as either strengths of the EPITI or opportunities for improvement. Repetition of meaning units/themes appeared during analysis, suggesting our PAR approach elicited meaningful and dependable data.

Results: AP experiences

Structure

Information content and structure: APs endorsed the information content and structure of the EPITI. They described the structure or information content of the EPITI as being streamlined and efficient, meaning information included on the EPITI met the information needs of AP. Clinical advantages ascribed to the EPITI generally related to increased structure, precision, and organization of PITS. In general, APs reported that the organization and presentation of the

information content of the EPITI improved the accuracy and precision of reporting patient information, and decreased ambiguity and discrepancies in communicated and written information transfers. Likewise, APs perceived that overall information omissions during PITS decreased. Increased organization was attributed to information being centrally located in a legible repository which was readily available for reference during PITS.

One AP stated: '*Handovers are more streamlined, I'm not fumbling for patient info, it's all right there on the form.'*

A number of questions arose about three information fields on the EPITI that seemed to be organized, in the opinion of the AP, around the recovering patient. The information fields pertained to whether the patient was on the correct type of bed, anesthesia orders were complete, and the AP had immediate access to vasoactive drugs in the PACU. The majority of AP felt these questions were not relevant to their practice. Likewise, AP felt including these information fields blurred the responsibilities of the AP because anesthetists don't typically enter post-operative orders and are not responsible for selecting the appropriate type of bed. However, there was consensus among AP that these information fields at least prompted the provider to consider these items as important to the process of PITS.

Regarding information content, AP stated the following additional fields needed to be added to the EPITI: central line access, ventilated patient with

mechanical ventilation settings, and intermittent use of vasopressors. It was suggested an additional explanatory field be added to the vasopressor information field to allow AP an opportunity to explain the intent and context of use of certain drugs.

Hardware resource availability: Several operational concerns were expressed by AP while pilot testing the EPITI. Most providers felt additional computers kiosks, iPads or other smart devices were needed in the PACU even though increased computer kiosks may congest the PACU environment. In fact, most AP remarked the most burdensome aspect of pilot testing the EPITI was limited computer access in the PACU. One AP felt limited access to available computers in the PACU contributed to communication issues with PACU nurses. Likewise, accessing computers that were not already in use was perceived by AP to be burdensome.

One provider stated:

'Which is why I was thinking we should really think about having iPad. Then we could have it, carry it...it's so easy to use. I think it's [iPad] much easier to use.'

Process

Accessing the EPITI: Accessing the EPITI once AP reached the PACU and was ready to participate in the handover was noted to be challenging at

times. AP stated there were too many steps to access the EPITI which increased the time required for PITS.

Improved efficiency of PITS: PITS were described by APs as being smoother, more efficient, organized and succinct. There was a tendency to communicate the most relevant information during PITS. Regarding the concept *ease of use*, the EPITI was described as being "easier to use over time". There was an initial learning curve associated with pilot testing the EPITI, and was described by AP as being the length of time it took to become familiar with incorporating the EPITI into PITS. As a result, AP felt PITS were much slower at the inception of the pilot test phase.

One AP stated: '*At first, I had to keep cross checking what I entered [onto the EPITI] with the pre-op record and the anesthesia record…Once I got used to it, it was easy'*

Level of burden: Because patient information did not pre-populate on the EPITI, AP attributed entering patient information as a potential burden, or an additional step, during pilot testing the EPITI. There was a sense that patients with higher acuity required more vigilance, therefore allowing less time to enter information on the EPITI. AP remarked entering patient information required adjustments in time management while maintaining vigilance over the patient. Information sharing between providers improved while pilot testing the EPITI. The EPITI was perceived by AP to be burdensome during short cases as well as

cases with complex patients. Likewise, AP stated entering patient information was another step in the process, meaning after AP manually recorded information on the traditional anesthesia record, information had to be entered on the EPITI. Despite the additional step of entering patient information, one AP stated the EPITI saved time during PITS in the PACU.

Communication: AP remarked on the effect of the EPITI on communication between AP and PACU nurses. Most AP stated communication between AP and PACU nurses was streamlined and therefore improved with the EPITI. Improved communication between AP and PACU nurses was attributed to the perceived precision and accuracy of the EPITI by AP. In general, AP felt communication between the AP and PACU nurse could be improved if the PACU nurse could access the EPITI prior to the patient arriving in the PACU.

Anticipatory planning: AP shared their perceptions of how implementing the EPITI could influence PACU nurse practices. For example, AP felt PACU nurses could engage in more anticipatory planning prior to the handover. Most AP stated the PACU nurses wouldn't have to write as much information during PITS if the PACU nurse referenced the EPITI prior to receiving the patient. Also, AP stated PACU nurses could spend more time listening to report while referencing the EPITI and less time writing. One AP observed PACU nurses recording less information on the standard written form. However, several AP remarked they noticed PACU nurses were multitasking as the AP was

referencing the EPITI. One AP felt the EPITI forced communication during PITS to become too scripted and structured.

Changes in PIT routines: Likewise, AP stated incorporating the EPITI into current handover practices represented a new routine which increased the time required for PITS. One AP stated it was difficult to break old habits and in some instances, PITS were longer. One provider stated '*there were less words but more value to the words…*'

AP observed PACU nurses weren't recording as much patient information of the standard handover form when the EPITI was being pilot tested.

Opportunity for process improvement: Because the EPITI did not pre-populate intra-operative information, AP entered peri-operative patient information. Some AP indicated entering patient data was challenging during complicated cases.

One AP stated: '*The integrity of the intraoperative record [anesthesia record] may be questioned if data are manually entered'.*

Another AP stated: '*What if I enter the wrong patient info… then the record is messed up.'*

Training/orientation to EPITI: One of the major opportunities for improvement was related to lack of training and orientation prior to pilot testing the EPITI. When asked about their initial experiences with pilot testing the EPITI, AP stated they would have preferred to have a more structured, yet brief,

orientation to the process of pilot testing the EPITI. Providing access to the EPITI for the PACU nurses was also indicated as an opportunity for improvement. AP felt the PACU nurses should be able to access the EPITI after the handover to address unresolved questions. Lack of clarification of the goal and intent of the EPITI was described as a barrier to pilot testing the EPITI.

Transitioning to an electronic record: AP felt that using the EPITI provided an opportunity for providers to practice and prepare for the department's upcoming transition to electronic records. One potential obstacle associated with pilot testing the EPITI was disturbances or breaches in the department's Wifi, internet access. AP mentioned a prior malware virus would have prevented accessing the electronic instrument. If there had been a malware incident during pilot testing, AP stated they would have conducted the handover with traditional methods.

During PITS, some AP stated they observed PACU nurses 'still writing down' information despite having access to the EPITI. Overall, AP stated they observed mixed reactions from PACU nurses about pilot testing the EPITI. Several AP remarked PACU nurses were initially reluctant to access the EPITI, while other AP remarked some PACU nurses preferred the EPITI over traditional handovers.

Outcomes

A majority of AP stated the EPITI had the potential to improve patient safety and improve quality of care.

Results: PACU nurse experiences

Structure

Improved efficiency of PITS: Overall PACU nurses endorsed the structure of the EPITI. PACU nurses remarked the structure and information content of the EPITI was streamlined, seamless and integrated well into practice when compared to the traditional handover from. One PACU nurse stated an additional field needs to be added to the EPITI to indicate whether the patient was stable on arrival to the PACU. When compared to the standard handwritten handover form, PACU nurses stated the EPITI was legible and: '*you're not trying to decipher what somebody's handwriting says it can just be on the screen.'* One PACU nurse stated communication errors could be decreased because the EPITI was far more legible than handwritten reports. Likewise, the information content of the EPITI was described as being thorough and comprehensive.

Process:

Availability of PIT information: Because the EPITI could be referenced electronically, meaning it could be left on the computer screen of bedside kiosks, PACU nurses felt their time as well as the AP time was expedited during handover. One PACU nurse stated if she was busy with another patient, she could easily glance at the computer screen to obtain information about the new

patient she was receiving. There was consensus among PACU nurses that the AP didn't have to wait for the PACU nurse to become available. Incorporating the EPITI into handover practices allowed the PACU nurse to multitask and prioritize other patient activities while listening to and referencing the EPITI. As a result, PACU nurses felt they didn't have to manually record as much patient information because it was already on the EPITI. One PACU nurse stated: '*We can be doing other things that we would have [had to] at least had stopped because they're getting a proper report'.* In general, PACU nurse felt communication between AP and PACU nurses was improved. Also, PITS were described as being more efficient.

Outcomes: There was consensus among PACU nurses regarding the potential of the EPITI to improve patient safety and reduce communication errors which could lead to delays in initiating treatments.

Opportunity for improvement

Revised format of EPITI: One PACU nurse stated scrolling through the EPITI was time consuming, and suggested the EPITI be reformatted into one visual page with section headers similar to the standard handover form. One PACU nurse identified lack of an information field to document the occurrence of unanticipated postoperative patient events after the surgery and before the patient arrived to the PACU. Further discussions revealed consensus among PACU nurses that an additional text box for adverse events should be added to

the EPITI, as all patient events are not structured and may not be categorized based on the predetermined information shields.

Blurred Responsibilities: Another opportunity for improvement was related to the time between the AP delivering the patient to the PACU and when the PACU nurse actually accepted responsibility for the care of the patient. PACU nurses felt there were blurred responsibilities during this time and requested an additional information field to be added to the EPITI to designate the patient has been formally transferred from the AP to the PACU nurse.

Quantitative Results: Provider Evaluation of Feasibility

Table 3 displays results from Fisher's exact test for the initial AP survey. The majority of AP indicated the EPITI was acceptable when implemented into practice (78.6%; *p*- value=.057), integrated well in postoperative handover routines (92.9%, p-value=.002), and met the information needs of the AP (92.9%, *p*=.002). Regarding organization of PIT activities, i.e. timing, AP felt it was not necessary to reorganize their time while pilot testing the EPITI (85.7%, *p*=.013). Assessing the level of burden associated with the EPITI, 57.1% of AP felt that implementing the EPITI was associated with increased burden. AP indicated interpersonal communication with PACU nurse did not overwhelmingly improve (57.1%, *p*=.791). The EPITI was implemented as intended (78.6%, *p*=.057) and AP indicated they received adequate training (78.6%). One half of AP agreed near misses could be prevented with implementing the EPITI (50%, *p*=1.00).

Table 3 AP Feasibility Survey Results

	Agree with feasibility	Did not agree with feasibility	df	*P* value
Acceptability	78.6%	21.4%	1	.057
Integration	92.9%	7.1%	1	.002
Timing	85.7%	14.3%	1	.013
Level of burden	57.1%	42.9%	1	.791
Information content	92.9%	7.1%	1	.002
Interpersonal communication	42.9%	57.1%	1	.791
Intended use	78.6%	21.4%	1	.057
Near misses	50.0%	50.0%	1	1.00
Orientation/ training with EPITI	71.4%	28.6%	1	.180

Overall, AP indicated the EPITI had the potential to improve patient safety, facilitated communication of pertinent patient information and was easy to follow during PITS.

PACU nurse feasibility results

Results of the PACU nurse feasibility survey (n=5) were reported as percentages of responses and are displayed in Table 4. All PACU nurse responses on the survey indicated the EPITI had the potential to improve patient safety. Eighty percent (4/5) of PACU nurse respondents were satisfied with the process of implementing (acceptability) and integrating the EPITI into practice. Likewise, 80% of PACU nurses felt the EPITI met their information needs, was implemented as intended, facilitated communication of patient information and was easy to follow. Sixty percent (3/5) of PACU nurses indicated communication between AP and PACU nurses improved and that they received sufficient training

and orientation prior to pilot testing the EPITI. Likewise, 60% of PACU nurses indicated it was necessary to reorganize their time while pilot testing the EPITI., 40% (2/5) of PACU nurses, respectively, indicated an increased level of burden while pilot testing and that indicated unanticipated adverse events could be avoided.

Table 4 PACU nurse Feasibility Survey Results (N=5)

	Agree with feasibility	**Did not agree with feasibility**
Acceptability	80%	20%
Integration	80%	20%
Timing	40%	60%
Level of burden	60%	40%
Information content	80%	20%
Interpersonal communication	60%	40%
Intended use	80%	20%
Near misses	40%	40%*
Orientation / training with EPITI		
Patient safety	100%	
Communication	80%	20%
Ease to follow	80%	20%

*missing value

***Triangulation of qualitative and quantitative results*:**

In general, quantitative results from the surveys supported qualitative findings.

Acceptability: Qualitative and quantitative findings indicated AP and PACU nurses were receptive and responded favorably to the EPITI. In general, both providers liked the legibility and centralized location of patient information.

Integration: While qualitative and quantitative findings indicated the EPITI integrated well into practice, AP and PACU nurses highlighted operational issues related to limited computer access in the PACU and accessing the EPITI form

once a computer became available. One rationale for this divergence in responses is that AP and PACU nurses may have felt the EPITI integrated well into practice because it provided increased organization of patient information despite operational issues experienced during pilot testing.

Time management: When surveyed, the majority of AP indicated it was necessary to reorganize their time when using the EPITI when compared to paper charting. Qualitative findings supported this point by indicating PITS were somewhat longer when implementing the EPITI. AP noted it was necessary to reorganize the sequence of tasks involved with transferring patients from the OR to the PACU nurse. Meaning, referencing the EPITI added an additional step in the information transfer process.

Level of burden: Qualitative findings indicated using the EPITI during short surgical cases, complex surgical cases or surgical cases with high acuity patients was considered burdensome. Quantitative findings supported that the EPITI was associated with increased level of burden. In addition, AP and PACU nurses remarked the ease of use of the EPITI increased as they gained more experience with using the form.

Information content: AP and PACU nurses were satisfied with the information content of the EPITI and their responses indicated the EPITI met the information needs of providers. AP posed questions during focus group discussions regarding the importance of the following three of the information fields: patient

on the correct bed, vasopressors available and PACU orders complete. When explained to AP from the perspective of PACU nurses, AP acknowledged the importance of including these three fields.

Interpersonal communication: When compared, qualitative and quantitative findings related to interpersonal communication diverged and revealed different responses. Survey results indicated 57.1% of AP and 60% of PACU nurses felt interpersonal communication improved while using the EPITI. However, some AP qualitatively reported interpersonal communication improved while some AP stated communication remained the same. One AP remarked inter-personal communication improved because the PACU nurse could listen to the handover report and write less. PACU nurses remarked interpersonal communication improved. Differences in opinions about the effect of the EPITI on interpersonal communication could be related to AP and PACU nurses' perceived level of importance of the communication of certain pieces of information.

Intended use: There was consensus between qualitative and quantitative findings regarding the intended use of the EPITI.

Near misses and patient safety: When surveyed, about 50% of AP and PACU nurses indicated implementing the EPITI had the potential to prevent near misses and to improve patient safety. Qualitative findings supported the EPITI's potential positive impact on patient safety and preventing near misses. The

impact of the EPITI, and other electronic handover instruments, on patient safety and preventing near misses needs to be assessed in future research.

Orientation to the EPITI: Quantitative findings indicated AP and PACU nurses felt they received adequate training and orientation to the EPITI. However, focus group discussions revealed AP and PACU would have liked more formal training and orientation prior to implementing the EPITI.

Easy to follow: Quantitative findings indicated the EPITI was easy to follow during PITS. Findings from AP focus group discussions indicated AP felt the EPITI was streamlined, easy to follow and organized. During the initial pilot test phase, AP indicated there was a learning curve associated with following the format of a new PIT instrument.

Patient Outcomes

PACU Length of stay

The mean PACU length of stay during the pre-pilot test phase was 166.58 min, SD 158.79, where N=1573. During the pilot test phase, the total number of surgical cases was N= 1011, mean length of PACU stay was 180.36 min (SD 167.80). Overall, the mean PACU length of stay during the pilot test phase was longer when compared to the mean PACU length of stay during the pre-pilot test: this mean difference, - 13.772, 95% CI [-26.606, -.937] was significant, t (2582) = -2.10, p= .035.

A total of 60 cases were pilot tested. The PACU length of stay for 5 cases was not recorded and one case in the pilot test group was not matched with a similar pre-pilot test case. Results of propensity score matching yielded 54 matched cases. The mean PACU length of stay for matched pre pilot test cases (N=54) was 165.59 minutes; SD 130.55. The mean PACU length of stay for pilot test cases (N=54) was 172.39 minutes; SD 80.00. After matching similar cases, the mean PACU length of stay of patients whose AP and PACU nurses pilot tested the EPITI was not significantly different when compared to the mean PACU length of stay during the pre-pilot period as evidenced by t (-0.325), df =53, p= .745.

Pain scores on arrival

The odds of a patient's pain score not being > 5 on arrival to PACU was 1.48 times greater in the pilot test group vs. pre-pilot test [Odds ratio 1.48; 95%CI (1.02, 2.2)].

Completion of PACU orders

The odds of having completed PACU orders on arrival to PACU was 8.67 times greater in the pilot test group vs. pre-pilot test group [Odds ratio 8.67; 95% CI (4.9, 15.4)].

Discussion

Guided by the principles of PAR,[16] this sequential mixed methods pilot study investigated the feasibility of a provider derived (driven) electronic handover instrument, the EPITI, for implementation into PITS. One strength of the study was provider engagement through PAR as evidenced by AP and PACU nurses' receptivity to the EPITI and collaboration throughout the study. This approach allowed the PI and key stakeholders to collaborate in developing and testing a PIT instrument that met the needs of providers. By doing so, AP and PACU nurses were involved in not only in identifying a research problem, but also in designing a mechanism to address deficits in PITS. Successful recruitment of AP and PACU nurses can be attributed to early engagement of providers.

Additionally, perioperative leadership supported the research goal which was to improve PITS by developing an instrument to reflect the information needs of key stakeholders. Although inter-departmental hierarchal relationships may exist, our PAR approach afforded both types of providers opportunities to offer their professional insight. AP and PACU nurses were more receptive to pilot testing the EPITI because their buy-in was engaged at the beginning of the research process. By working together from the study's inception, the PI, AP and PACU nurses tailored and pilot tested the EPITI which was well adapted to meet the local needs of the patients, providers and PACU environment.[16] This approach facilitated AP and PACU nurses' recognition of the inclusion of their recommendations, which nurtured empowerment of AP and PACU to support research within the department.

Findings of this study supplement and are unique to extant literature while incorporating a PAR approach. In addition to pilot testing the EPITI, the study went a step further to evaluate the feasibility of implementing the EPITI. Weinger et al. sought to improve PITS by implementing a standardized electronic handover form.[35] Evaluation of PITS three years after implementing the electronic handover form revealed handovers remained significantly improved when compared to pre-study baseline evaluation of handover.[35] These results suggest the electronic handover form was feasible, similar to our results, and sustainable. Jayaswal et al. surveyed anesthesia providers to determine the

need for inclusion of the handover in the electronic medical record.[14] Sixty-two percent of anesthesia providers believed that handovers should be incorporated into the electronic medical record.[14] In this study AP and PACU nurses endorsed the EPITI and felt it should be integrated into the patient's electronic health record. Results of this study echo findings of similar studies that pilot tested a PIT protocol and checklist. In their pilot study, Petrovic et al. implemented a standardized postoperative handover protocol (OR to ICU).[36] Key elements of the protocol included defining the handover team, requiring their presence throughout the handover, transfer of information and technology, and a distinct question and answer period.[36] After implementing the protocol, handover satisfaction scores among ICU nurses increased from 61% to 81%.

Results of the feasibility survey indicated the EPITI was feasible when evaluated against the following outcomes: acceptability, integration into practice, timing and providers' organization during PITS, information content, and orientation to the EPITI. Responses were mixed regarding communication between PACU nurses and AP. While some providers remarked communication improved, other providers stated communication was about the same. Potentially, communication varied between providers based on their receptiveness and willingness to incorporate the EPITI into practice. For instance, if the PACU nurse was engaged in other patient care activities, the EPITI could be left on the computer screen and referenced at a later time. In this

case, the AP would communicate the highlights of the peri-operative course. This scenario could be interpreted as decreased communication; however, pertinent communication was still available and communicated to the PACU nurse.

Our initial intent was for AP and PACU nurses to examine and reference the EPITI simultaneously. We found that AP referred to the EPITI while delivering the verbal PIT to the PACU nurse, while in some instances, PACU nurses focused on the writing elements of the PIT on the standard "yellow" handover sheet. One defining reason for lack of mutual participation in referencing the EPITI during the handover could be that seasoned PACU nurses were entrenched in the handwritten process. In general AP and PACU nurses felt one of the difficulties of implementing the EPITI was breaking old habits. Some AP commented they preferred the handover report to tell a story of the patient's perioperative course. There was a sense the standardized form could hinder opportunities to present the most critical information first.[5] Thus, we acknowledge the need for a balance between reporting from the EPITI and informal PIT practices.

Accessing the EPITI once AP arrived in the PACU was challenging at the beginning of the study. Although AP was provided with a link, several steps had to be taken before the AP could enter the link on a computer. After these steps, the AP and PACU nurse could engage in the PIT. These activities typically

occurred after the patient was reattached to monitoring technology and before transferring the patient to the PACU nurse. As the study progressed, AP remarked there were too many steps to access the EPITI in the PACU. To address issues with access, EPITI icons were installed on all the laptop computers attached to the anesthesia machines and on all kiosk and laptop computers in the PACU. Installing the EPITI icon created a faster access point for providers. AP accessed the EPITI by clicking on the icon on the anesthesia laptop, entering peri-operative patient information, saving the data and recording the access code. On arrival to PACU, AP clicked on the EPITI icon, accessed the form and completed the PIT with the PACU nurse. After adding the EPITI icon, AP felt the process of accessing the form was more streamlined. Another benefit of creating the icon was that AP could share the access code with the PACU nurse. By sharing the access code, PACU nurses could access the EPITI after the AP left the PACU. Creating the EPITI icon addressed the PACU nurse's' concern about having access to the EPITI once the PIT was completed.

Lack of computer availability or having access to an available computer was described as being burdensome at times. At times, AP felt like they were invading the PACU nurses workspace which interrupted the flow of normal PACU routines. AP and PACU nurses agreed additional computers, either mobile kiosks, laptops or smart devices, would be needed as our institution transitions to electronic medical records. There were concerns that additional mobile kiosks

would create increased congestion because available space in the PACU is already limited. Several providers suggested portable smart devices, i.e. iPads or tablets, which could be issued to providers once the devices were encrypted to protect patient health information. Because this was a pilot study, purchasing additional computers was not incorporated into the study design. Launching a full scale study would include additional and adequate computer access.

Recruitment and retention of AP and PACU nurses:

Initially, the study recruited eight AP and PACU nurses, respectively, to pilot test the EPITI. The intent was for post-operative information transfers to be carried out in AP- PACU nurse dyads. As the study progressed, the PI and study coordinator could not predict to which PACU nurse the AP would transfer the patient. Because of the variability in the daily surgical case schedule and provider schedules, 12 AP pilot tested the EPITI and were recruited to participate in key informant focus groups. Five of the original eight PACU nurses who consented to pilot test EPITI actually participated in post-pilot testing key informant focus groups. Attrition of the original eight PACU nurses recruited to pilot test the EPITI was attributed to nurses being absent during the latter part of pilot testing phase of the study because of work related injuries and PACU nurses resigning from their respective /current positions. Likewise, several PACU nurses declined to participate in focus groups or did not respond to multiple invitations to participate in focus group discussions. Two providers were

given the option of participating in individual interviews; however, the providers declined and elected to answer focus group questions in writing. Overall, there was less participation with PACU nurses when compared to AP during Phases II and III of the study. Similar to this study, Robins et al. asked PACU nurses to recall elements of the handover and rate handover adequacy after receiving patients whose AP were randomized to performing the handover with or without a standardized checklist.[37] Data from eight of the original 52 PACU nurse participants was not available for analysis.[37] It's not uncommon for there to be attrition of study participants especially in our practice environment which experiences high rates of staff turnover.

Patient outcomes: There was a significant difference between the overall PACU length of stay prior to and during the pilot test phase of the study. It should be noted there were 562 more cases in the pre-pilot group compared to the pilot test group. The initial comparison compared all cases instead of select cases. The overall sample of pre pilot test and pilot test cases was large and consisted of a wide variety of cases. After matching similar cases and controlling for confounding factors, there was no significant difference in PACU length of stay. This finding could be attributed to a smaller, more homogeneous sample size and the fact there was fewer artifacts from various cases that were not similar to cases during the pilot test phase. Also, the main PACU experienced weekly PACU delays, meaning patient length of stay was extended during the study

timeframe because of the hospital's high patient census. Fewer beds were available in the hospital which meant patients spent more time in the PACU. Future research would need to document the time patients are eligible for discharge from the PACU.

We were unable to compare pain scores on arrival to PACU and completion of PACU orders for similar cases prior to and during the pilot test phase. This was due to inconsistencies in record keeping. Instead, the overall number of patients with pain scores greater than 5, which is the value our department records, was compared prior to and during pilot testing phases. The intent was to compare the pain scores of patients whose AP and PACU nurses pilot tested the EPITI with the pain scores of patients whose providers did not pilot test the EPITI. The EPITI contained an information field designed to prompt AP to manage and be prepared to manage pain control towards the end of the case through the PIT process. We were interested in determining if the addition of the information field would prompt AP to administer long acting pain medication or to have narcotics available for pain management in the immediate recovery setting. AP shared the addition of the "narcotics on hand" information field prompted them to carry narcotics to the PACU during patient transport.

PACU nurses noted that incomplete PACU orders served as a barrier to providing care in the immediate recovery setting. Therefore, we sought to determine if the additional of an information field addressing completed PACU

orders would prompt AP to verify PACU orders had been entered. We were unable to compare completion of PACU orders for similar cases prior to and during the pilot testing phases. We acknowledge there was a significant difference in the number of completed PACU orders between pre pilot and pilot test cases. However, we are cautious about drawing conclusions about the effect the EPITI had on the number of completed PACU orders because of the nature by which the data was collected and recorded.

Study Limitations

Additional steps can be taken to increase the validity and robustness of mixed methods studies. Although we discussed qualitative findings and their relation to quantitative results, while noting convergence and divergence of findings, the robustness of our process can been improved by developing qualitative interview guides that more accurately reflected quantitative survey questions. When designing future feasibility studies, attention will be directed to ensuring consistency among the questions developed for qualitative and quantitative analysis.

Our small sample sizes limit the generalizability of our results.[38] However, our findings regarding the structure and processes related to PITS echo results of similar studies.[14,15] Designing and implementing new PIT instruments is time consuming and required an iterative process of revisions while introducing inter-departmental PIT process changes. The timeframe for Phase II, pilot testing the

EPITI, could have been extended which would have increased the number of AP and PACU nurses who pilot tested the instrument.

One technical limitation of the EPITI was that the instrument was not integrated into our current EHR and therefore did not pre-populate peri-operative information. Because information did not pre populate, AP were tasked with entering the majority of peri-operative information. These findings may not be substantiated during real-time implementation of an electronic handover form integrated into an EHR. The level of burden regarding entering patient information experienced with the EPITI may be attenuated when implementing an integrated anesthesia management system.

There was incongruence and attrition of AP and PACU nurses who participated in tailoring the EPITI and PACU nurses who pilot tested and evaluated the feasibility of the EPITI. Although we included AP and PACU nurses during each phase of the study, the groups were not homogenous throughout the study. Reasons associated with lack of homogeneity included attrition of providers due to health concerns and changes in staff schedules. Resultantly, themes such as identifying additional information fields emerged later in the study. In addition, AP and PACU six nurses who participated in developing and tailoring the EPITI did not participate in pilot testing the EPITI, although their input was included as the EPITI was developed and revised.

Conclusions

Results of this pilot and feasibility study indicate the implementation of EPITI was feasible and acceptable to AP and PACU nurses. The EPITI offered an organized, succinct platform to improve the quality of PITS. This pilot and feasibility study provides sufficient support for a larger scale study to assess the effect of EPITI on patient specific outcomes. Favorable findings related to acceptability of the EPITI indicated the processes described in the development and design of this study could inform development of future electronic postoperative handover instruments.

Future research should include investigating the impact of launching the EPITI or a similar electronic handover form embedded in the electronic health record on patient outcomes, such as PACU length of stay, while controlling for peri-operative variables known to influence length of stay. Additional research is needed to expand our knowledge on the impact of electronic postoperative handover instruments on patient safety and patient outcomes.

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Summary

Overview of manuscripts

This dissertation compendium is comprised of three manuscripts: (1) a scoping study titled: *Factors Influencing patient Safety During Postoperative Handover*, (Rose & Newman, 2016) (2) an integrative review describing how post-operative information transfer protocols, checklists and tools have been developed, investigated, and evaluated in extant literature, and (3) a sequential exploratory mixed methods study designed to assess the feasibility of pilot testing the EPITI. Each manuscript builds upon prior knowledge gained in the previous manuscript. The goal of the scoping study was to identify factors at each level of the social ecological model that influence the conduct of post-operative information transfers. Underpinned by the Donabedian framework, results of the scoping study revealed individual, interpersonal, environmental, and organizational factors influence the quality of PITS. Intra- personal factors included individual communication styles; interpersonal factors were related to anesthesia and to PACU provider team dynamics; organizational environmental factors described the dynamic PACU environment; and organizational policy-level factors included emphasizing a culture of patient safety. This scoping review demonstrated a multilevel analysis of integrated factors affecting handovers and patient safety. Importantly, the scoping review suggested additional research should be designed to develop interventions at each level of

the social-ecological model to improve the quality of PITS.

Following the scoping review, an integrative review of extant literature was performed to synthesize and critique the literature related to protocols, checklists and tools designed to facilitate POH from the operating room (OR) to the PACU. Seventeen original research studies were identified that met inclusion criteria. Each study was categorized based on Wong et al.'s classification of intervention based studies (Wong, Yee, & Turner, 2008). Underpinned by the Donabedian Conceptual Model, studies were identified that standardized and evaluated processes related PITS, and described the impact of standardized PIT instruments on patient outcomes. Additional themes identified after synthesizing instruments included the inclusion of anticipatory guidance and descriptions of the purposes of the instruments. Recommendations for developing context specific PIT instruments include utilizing participatory action research (PAR) as a research approach, and designing a multi-modal research project to address the structure, process and patient outcomes related to PITS.

Subsequently, a sequential exploratory mixed methods study was undertaken to pilot test and assesses the feasibility of the Electronic Post-operative Information Transfer Instrument (EPITI). Phase I involved tailoring the EPITI based on data obtained from key informant AP and PACU nurse focus groups. During Phase II, the EPITI was pilot tested for 60 PITS. Phase III included qualitatively and quantitatively assessing the feasibility of implementing

the EPITI and assessing the EPITI for signal of effect on PACU length of stay. Seventeen providers, 12 AP and five PACU nurses participated in pilot testing the EPITI. Overall, results of the study indicated AP and PACU nurses felt the EPITI was acceptable, integrated well into practice and improved interpersonal communication between providers. Results indicated it is practical to standardize PITS through implementation of the EPITI. However, additional research is needed to develop and implement sustainable electronic PIT instruments and to determine if implementing those instruments has a positive effect on quantifiable patient outcomes.

Limitations/ lessons learned

Initially, the pilot and feasibility study recruited eight AP and PACU nurses, respectively, to pilot test the EPITI. The intent was for post-operative information transfers to be carried out in AP-PACU nurse dyads. As the study progressed, the PI and study coordinator could not predict to which PACU nurse the AP would transfer the patient. Because of the variability in the daily surgical case schedule and provider schedules, 12 AP pilot tested the EPITI and were recruited to participate in key informant focus groups. Five of the original eight PACU nurses who consented to pilot test EPITI actually participated in post-pilot testing key informant focus groups. Attrition of the original eight PACU nurses recruited to pilot test the EPITI was attributed to nurses being absent during the latter part of pilot testing phase of the study because of work related injuries and

PACU nurses resigning from their respective /current positions. Likewise, several PACU nurses declined to participate in focus groups or did not respond to multiple invitations to participate in focus group discussions. Two providers were given the option of participating in individual interviews; however, the providers declined and elected to answer focus group questions in writing.

From these experiences, we learned to anticipate attrition of recruited participants and to solicit additional participants as needed. One of the reasons we were able to recruit additional participants without issue was because we established buy in from AP and PACU nurses at the inception of the study. Engaging providers early in the development of the research design relieved the burden of replacing participants later in the study (Schmittdiel, Grumbach, & Selby, 2010). Moreover, participant attrition in this study demonstrated the importance of recognizing shifts in staffing models and scheduling.

One of the challenges associated with pilot testing the EPITI was accessing the form once AP entered the PACU. In retrospect, the shortcut icon to access the EPITI could have been created earlier and placed on computers attached to the anesthesia machines and on computers in the PACU. The shortcut icon would have eliminated several steps AP had to take to access the EPITI and enter patient information. Likewise, the shortcut icon would have decreased the time AP and PACU nurses spent in the PACU accessing the EPITI. While this pilot study assessed the feasibility of implementing an

electronic handover form, launching a full scale electronic form would require additional computer kiosks in the PACU. A full scale study would incorporate additional computers, whether kiosks or handheld devices, into the research design. Additional financial resources and manpower would need to be secured to operationalize a full scale study.

On the basis of anecdotal feedback from AP and PACU nurses, we learned both providers needed a formal orientation to the pilot testing process. The pilot test process would have been smoother if the study design had included orientation and training sessions prior to pilot testing the EPITI. Incorporating orientation and training sessions prior to pilot testing the EPITI would have addressed some of the technical and process questions providers experienced while during the pilot test phase. Moreover, AP and PACU nurses who completed the orientation and training sessions could have been incentivized to serve as super users. Depending on their schedules, these super users could have served as resources for other providers during the pilot test phase.

One of the aims of this dissertation research was to compare pain scores on arrival to PACU and completion of PACU orders prior to and during pilot testing the EPITI for similar patients and surgical cases. Pain scores on arrival to PACU and completion of PACU orders are manually recorded on quality assurance forms by the PACU nurse. Data for these two outcomes were not

captured because the quality assurance forms were recycled prior to recording data. Therefore, we learned to meticulously retain data during the research study until all data related to outcome measures are captured, recorded and analyzed.

Contribution of research to nursing

A major gap in the literature was a lack of studies that assessed patient outcomes after implementing electronic or traditional handover instruments. Findings from this dissertation addressed this gap by comparing PACU length of stay for similar cases prior to and during pilot testing the EPITI. Tailoring and pilot testing the EPITI supported the Joint Commission's 2006 National Patient Safety Goals which initiated a patient safety standard requiring all health care providers implement a standardized approach to postoperative handovers (Patterson & Wears, 2010). Further, our PAR approach to investigating postoperative information transfers demonstrates the value of engaging AP and PACU nurses in research that impacts clinical practice (Schmittdiel et al., 2010).

Future research

Patient safety is the most important outcome when developing post-operative information transfer instruments. Including the incidence of patient safety or adverse patient events as an outcome measure should be considered when designing future studies. The goal is to compare the incidence of patient safety or adverse patient events in patients whose AP and PACU nurses

implemented standardized post-operative information transfer instruments to patients whose providers did not implement standardized instruments. After controlling for confounding variables, such as coexisting diseases and surgical complications, future research needs to be conducted to assess a standardized handover for signal of effect on patient safety and the incidence of adverse patient outcomes.

Additional research is needed to explore the effect of interpersonal factors, such as team behaviors, interpersonal communication, and shared understanding on post-operative information transfers (Catchpole & Russ, 2015; Manser, Foster, Gisin, Jaeckel, & Ummenhofer, 2010). A well-defined post-operative information instrument supports the structure and organization of information transfers (Catchpole & Russ, 2015). However, the providers' ability to integrate, prioritize and recall pertinent information may affect the success of standardizing information transfers (Catchpole & Russ, 2015). Randmaa et al. conducted an observational study to determine how much information receiving providers were able to recall after the postoperative handover and to determine factors influencing providers' ability to recall information (Randmaa, Mårtensson, Swenne, & Engström, 2015). Their study found that lack of standardization and prolonged duration of the handover event decreased the amount of information the receiving provider was able to recall (Randmaa et al., 2015). Results of this study indicate future research is needed to assess the effect of standardized

post-operative information transfers on information recall and prioritization of information. Additional research is needed to identify barriers to interpersonal communication among AP and PACU nurses that potentially lead to information omissions. A qualitative descriptive research design with key information focus groups would reveal latent interpersonal relations that negatively impact the quality of postoperative information transfers. Findings from this dissertation support the growing body of literature that investigates the incorporation of electronic postoperative handover instruments. Results from the literature review revealed three studies that investigated electronic post-operative information transfer instruments (Gillikin & Apatov, 2016; Jayaswal et al., 2011; Weinger et al., 2015). Additional research is needed to assess electronic post-operative information transfer instruments for signal of effect on pre-identified patient safety outcomes such as re-intubations in the PACU, delays in medical treatment and longitudinal mortality rates (Segall et al., 2012).

Research trajectory

The Department of Anesthesiology at the study site where the dissertation research was conducted is scheduled to launch an electronic anesthesia information management system (AIMS). The AIMS will include an electronic post-operative information transfer instrument. We aim to incorporate results from this dissertation into the design of the AIMS. Our goal is to communicate our findings from PAR related to the structure and processes of post-operative

information transfers and to inform development of the electronic handover form. Likewise, the research trajectory aims to measure the following patient outcomes prior to and during implantation of the AIMS: adverse patient events, presence of PACU orders, PACU length of stay, pain scores on arrival to PACU and the duration of postoperative information transfers.

Conclusions

The current study is an important contribution to extant literature on post-operative information transfers between AP and PACU nurses. Many of the findings from the qualitative and quantitative mixed analyses were consistent with previous research that developed; pilot tested and evaluated PIT instruments. Although triangulation of results revealed minimal inconsistencies between qualitative and quantitative finds, we recognize the complex nature of PITS and the multiple factors influencing information transfers. This dissertation work has provided preliminary work that can be used to guide practical and sustainable interventions to improve the quality of PITS and ultimately improve patient safety and patient outcomes.

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Appendices

Preliminary Work

Research

Appendix A. The MedStar Health Research Institute IRB approval letter for preliminary work/focus groups; Manuscript III

MedStar Health
Research Institute

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Exempt Determination Notice
Initial Review

20-Oct-2015

425 Oglethorpe St NW
Washington, DC 20011

Protocol Number: **2015-203**
PI Name: **Monica Rose**
Protocol Title: **Assessing Information Needs and Practices in Post-operative Information Transfers**

Dear Monica Rose,

The above-referenced **Initial Review** submission was reviewed by the Office of Research Integrity (ORI) on **12-Oct-2015**.

It has been determined that your study meets the criteria set forth in **[45 CFR 46.101(b), Category (2)]** and qualifies for exemption from the requirements of [45 CFR 46] federal regulations. In the event changes are made to the protocol, which may affect this determination, please submit documentation of this change for review prior to implementation.

Please refer to the Office of Research Integrity website to review the **Principal Investigator's Responsibilities** as a MedStar researcher on http://www. medstarresearch.org/Body.cfm?id=243.

If you have any questions, please contact me at 301-560-7339.

Thank you,

Crystal Bland
Office of Research Integrity

Enclosure: IRB Stamped Recruitment Materials(Flyers & Focus Group Questions)

Knowledge and Compassion
Focused on You

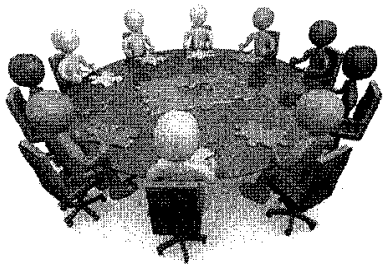
Assessment of Information Needs and Practices in Post-operative Information Transfers

Focus Group Questions:

1. Please identify your information needs during post-op handovers. What information do you think is absolutely necessary to be communicated to safely transfer care?
2. Please identify factors that positively impact post-op handovers. What are some current post-op handover practices that are working well?
3. Please identify factors that serve as barriers to conducting post-op handovers. What are some current post-op handover practices that need to be improved?
4. What process improvements would you make to improve post-op handovers?
5. What do you think is the critical value of implementing a standardized post-op handover protocol?

Let's Focus on Post-op Handovers

Anesthesia Provider Focus Group



You are cordially invited to attend a focus group especially for PACU nurses to discuss post-op handovers.

Goal: To identify what's working with handovers and what can we do better?

Date:

Time:

Location:

Your participation is strictly voluntary. Refreshments and beverages provided.

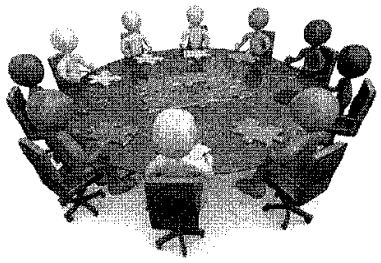
IRB approval #.

Please email Monica Rose, CRNA, Department of Anesthesiology monica.w.rose@medstar.net to sign up.

Feel free to contact Monica with questions.

Let's Focus on Post-op Handovers

PACU Nurse Focus Group



You are cordially invited to attend a focus group especially for PACU nurses to discuss post-op handovers.

Goal: To identify what's working with handovers and what can we do better?

Date:

Time:

Location:

Your participation is strictly voluntary. Refreshments and beverages provided.

IRB approval #.

Please email Monica Rose, CRNA, Department of Anesthesiology monica.w.rose@medstar.net to sign up.

Feel free to contact Monica with questions.

Appendix B. The MUSC IRB approval letter for preliminary work/focus groups; Manuscript III

Institutional Review Board for Human Research (IRB)
Office of Research Integrity (ORI)
Medical University of South Carolina

Harborview Office Tower
19 Hagood Ave., Suite 601, MSC857
Charleston, SC 29425-8570
Federal Wide Assurance # 1888

APPROVAL:
This is to certify that the research proposal **Pro00048641** entitled:
Assessing Information Needs and Practices in Post-operative Information Transfers

Submitted by: **Monica Rose**
Department: **Medical University of South Carolina**

for consideration has been reviewed by **IRB-I - Medical University of South Carolina** and approved. In accordance with 45 CFR 46.101(b)(2), the referenced study is exempt from Human Research Subject Regulations. No further action or Institutional Review Board (IRB) oversight is required, as long as the project remains the same. However, you must inform this office of any changes in procedures involving human subjects. Changes to the current research protocol could result in a reclassification of the study and further review by the IRB.

Because this project was determined to be exempt from further IRB oversight, consent document(s), if applicable, are not stamped with an expiration date.

Research related records should be retained for a minimum of three years after termination of the study.

Approval Date: **9/16/2015**

Type: **Exempt**

Administrator, **IRB - Medical University of South Carolina**
Katherine Bright

☐***Electronic Signature****: This document has been electronically signed by the IRB Chairman through the HSSC eIRB Submission System authorizing IRB approval for this study as described in this letter.*

Appendix C. Anesthesia provider preliminary focus group invitation;

Manuscript III

Let's Focus on Post-op Handovers

Anesthesia Provider Focus Group

You are cordially invited to attend a focus group especially for PACU nurses to discuss post-op handovers.

Goal: To identify what's working with handovers and what can we do better?
Date:
Time:
Location:

Your participation is strictly voluntary. Refreshments and beverages provided.
IRB approval #.
Please email Monica Rose, CRNA, Department of Anesthesiology
monica.w.rose@MedStar.net to sign up.

Appendix D. PACU nurse preliminary focus group invitation; Manuscript III

Let's Focus on Post-op Handovers

PACU Nurse Focus Group

You are cordially invited to attend a focus group especially for PACU nurses to discuss post-op handovers.

Goal: To identify what's working with handovers and what can we do better?
Date:
Time:
Location:
Your participation is strictly voluntary. Refreshments and beverages provided.
IRB approval #.
Please email Monica Rose, CRNA, Department of Anesthesiology
monica.w.rose@MedStar.net to sign up.

Appendix E. Preliminary work focus group interview guide; Manuscript III

Assessment of Information Needs and Practices in Post-operative Information Transfers

Focus Group Questions:

1. Please identify your information needs during post-op handovers. What information do you think is absolutely necessary to be communicated to safely transfer care?
2. Please identify factors that positively impact post-op handovers. What are some current post-op handover practices that are working well?
3. Please identify factors that serve as barriers to conducting post-op handovers. What are some current post-op handover practices that need to be improved?
4. What process improvements would you make to improve post-op handovers?
5. What do you think is the critical value of implementing a standardized post-op handover protocol?

Appendix F. The MedStar Health Research Institute IRB approval letter

MedStar Health
Research Institute

6525 Belcrest Road
Suite 700
Hyattsville, MD 20782
301-560-7300 PHONE
301-560-7348 FAX
medstarresearch.org

Approval Notice
Initial Review

01-Feb-2016

425 Oglethorpe St NW
Washington, DC 20011

Protocol Number: **2016-002**
PI Name: **Monica Rose**
Protocol Title: **Assessing Post-operative Information Transfers: A pilot and feasibility study**

Dear Monica Rose,

The above-referenced **Initial Review** submission was reviewed by **IRB # 3 Washington** in accordance with expedited review procedures on **25-Jan-2016**.

Request for waiver of written documentation of Informed Consent, approved.

The IRB has approved the submission. You can begin research activities. **The approval is valid from *25-Jan-2016* through *24-Jan-2017***. Any modifications to the IRB-approved protocol and other supporting documents must be reviewed and approved by the IRB prior to implementation.

If the study will continue beyond *24-Jan-2017*, please submit a continuation request form forty-five (45) days prior to *24-Jan-2017* to allow the IRB sufficient time to review and approve the request.

Please refer to the Office of Research Integrity website to review the **Principal Investigator's Responsibilities** as a MedStar researcher on http://www. medstarresearch.org/Body.cfm?id=243.

If you have any questions, please contact me at 301-560-7339.

Thank you.

Crystal Bland
Office of Research Integrity

Enclosure: IRB Stamped HIPAA Waiver
IRB Stamped Participant Materials (Group Invite & Focus Group Questions)

Appendix G. The MedStar Health Research Institute IRB amendment approval notice

MedStar Health
Research Institute

6525 Belcrest Road
Suite 700
Hyattsville, MD 20782
301-560-7300 PHONE
301-560-7348 FAX
MedStarResearch.org

Approval Notice
Amendment

02-Aug-2016

425 Oglethorpe St NW
Washington, DC 20011

Protocol Number: **2016-002**
PI Name: **Monica Rose**
Protocol Title: **Assessing Post-operative Information Transfers: A pilot and feasibility study**

Dear Monica Rose,

The above-referenced **Amendment** submission was reviewed by **IRB # 3 Washington** in accordance with expedited review procedures on **01-Aug-2016**.

The IRB approved the following modification(s): **Modification of existing materials: HIPAA documentation. Addition of research personnel -Vanessa Emmanuel Baker, Martina Mueller**

The approval is valid through *24-Jan-2017*. Any modifications to the IRB-approved protocol and other supporting documents must be reviewed and approved by the IRB prior to implementation.

If the study will continue beyond *24-Jan-2017*, please submit a continuation request form forty-five (45) days prior to *24-Jan-2017* to allow the IRB sufficient time to review and approve the request.

If you have any questions, please contact me at 301-560-7339.

Thank you,

Crystal Bland
Office of Research Integrity

Knowledge and Compassion
Focused on You

Appendix H. The MUSC IRB approval letter

Institutional Review Board for Human Research (IRB)
Office of Research Integrity (ORI)
Medical University of South Carolina

Harborview Office Tower
19 Hagood Ave., Suite 601, MSC857
Charleston, SC 29425-8570
Federal Wide Assurance # 1888

APPROVAL:
This is to certify that the research proposal **Pro00051955** entitled:
Assessing Post-operative Information Transfers: A pilot and feasibility study

Submitted by: **Monica Rose**
Department: **Medical University of South Carolina**
Sponsor: **American Associatin of Nurse Anesthetist Foundation Doctoral Fellowship Program 2016 F-2**

For consideration has been reviewed by **IRB-I - Medical University of South Carolina** and approved with respect to the study of human subjects as adequately protecting the rights and welfare of the individuals involved, employing adequately methods of securing informed consent from these individuals and not involving undue risk in the light of potential benefits to be derived there from. Additionally, the Institutional Review Board for Human Research (IRB) recommends approval of the investigator's request for Waiver of Signed Consent in accordance with 45 CFR 46.117I(1),(2) because the only record linking the subject and the research would be the consent document and the principal risk would be potential harm resulting from a breach of confidentiality and/or because the research presents no more than minimal risk and involves no procedures for which written consent is normally required outside of the research context. The Institutional Review Board for Human Research (IRB) also recommends approval of the investigator's request for Waiver of Consent pursuant to 45 CFR 46.116(d) because the research involves no more than minimal risk to the subject, the waiver will not adversely affect the rights and welfare of the subjects, and the research could not be practicably carried out without the waiver. No IRB member who has a conflicting interest was involved in the review or approval of this study, except to provide information as requested by the IRB.

Original Approval Date: **4/27/2016**
Approval Expiration: **4/26/2017**

Type: **Expedited**

Chairman, **IRB-I – Medical University of South Carolina**
Mark Hamner*

Statement of Principal Investigator:

As previously signed and certified, I understand that approval of this research involving human subjects is contingent upon my agreement:

1. To report to the Institutional Review Board for Human Research (IRB) any adverse events or research related injuries which might occur in relation to the human research. I have read and will comply with IRB reporting requirements for adverse events.
2. To submit in writing for prior IRB approval any alterations to the plan of human research.
3. To submit timely continuing review reports of this research as requested by the IRB.
4. To maintain copies of all pertinent information related to the research activities in this project, including copies of informed consent agreements obtained from all participants.
5. To notify the IRB immediately upon the termination of this project, and/or the departure of the principal investigator from this Institution and the project.

☐ ***Electronic Signature****: This document has been electronically signed by the IRB Chairman through the HSSC eIRB Submission System authorizing IRB approval for this study as described in this letter.*

Initial Review Approval of Full Board or Expedited Research 11/29/2016

Appendix I. MedStar Washington Hospital Center, Department of Anesthesiology letter of support

Washington
Hospital Center
MedStar Health

Department of Anesthesiology

January 5, 2016

As Chairman of the Department of Anesthesiology at Medstar Washington Hospital Center, I am writing to express my support for your study: Assessing Post-operative Information Transfers: A pilot and feasibility study. You may use our facilities to pilot test the electronic post-operative information transfer instrument (EPITI), and to conduct focus groups to assess the feasibility of the EPITI. I wish you much success with your research.

Sincerely,

E. Begin

Eileen V. Begin, MD

110 Irving Street, NW, Room G-226, Washington, DC 20010-2975
phone: 202 877 7500 • *fax:* 202 877 5075

Appendix J. MedStar Washington Hospital Center, Perioperative Services letter of support

MedStar Washington
Hospital Center

110 Irving Street, NW
Washington, DC 20010-2975
202-877-7000 PHONE
medstarwashington.org

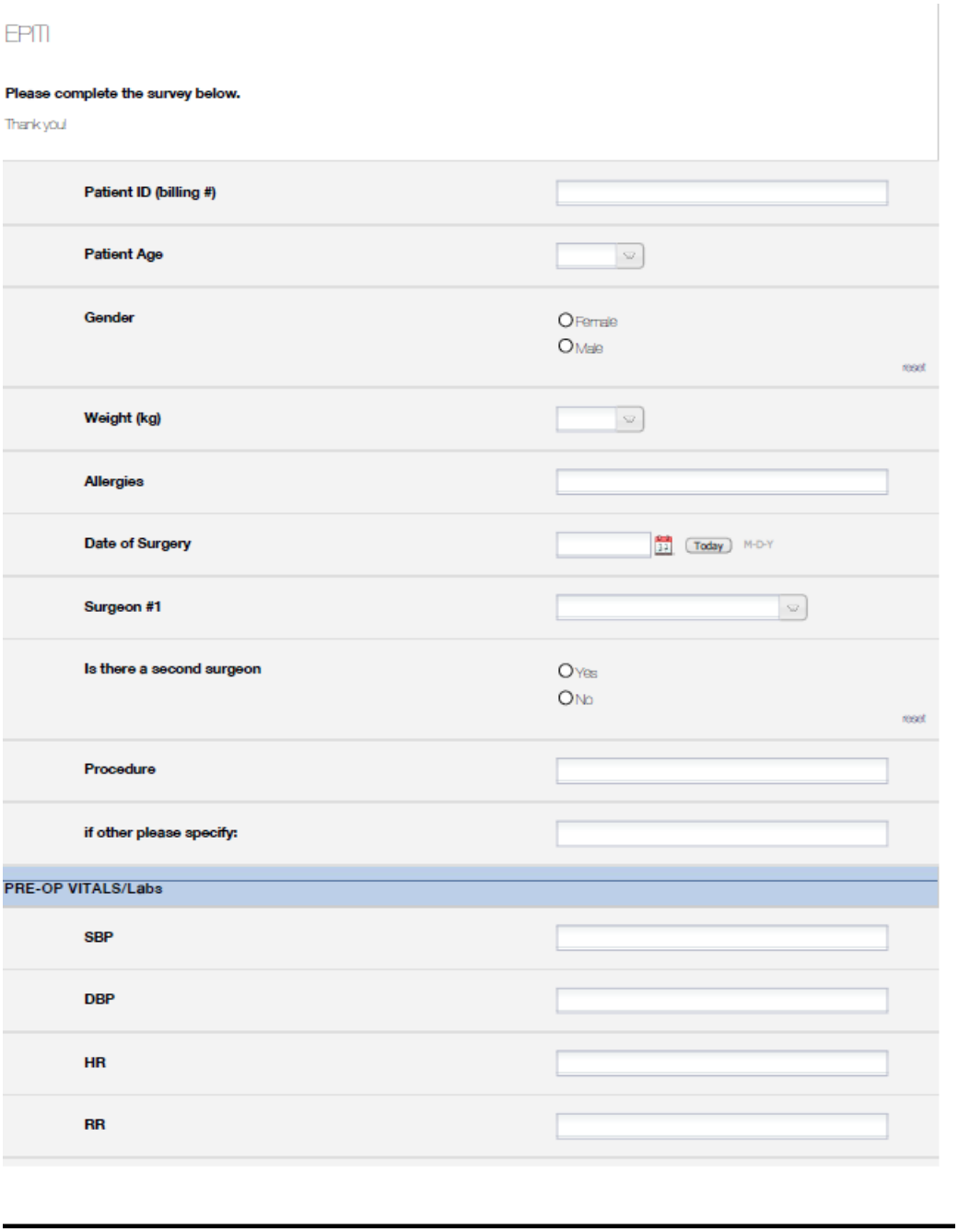
January 5, 2016

As Vice President of Peri-operative Services at Medstar Washington Hospital Center, I am writing to express my support for your study: Assessing Post-operative Information Transfers: A pilot and feasibility study. You may use our facilities to pilot test the electronic post-operative information transfer instrument (EPITI), and to conduct focus groups to assess the feasibility of the EPITI. I wish you much success with your research.

Sincerely,

Caren Lewis, MSHA, BSHA, BSN, RN
Vice President, Perioperative Services

Appendix K. The electronic information transfer instrument (EPITI); Manuscript III



EPITI

Please complete the survey below.

Thank you!

Patient ID (billing #)	
Patient Age	
Gender	○ Female ○ Male reset
Weight (kg)	
Allergies	
Date of Surgery	Today M-D-Y
Surgeon #1	
Is there a second surgeon	○ Yes ○ No reset
Procedure	
if other please specify:	
PRE-OP VITALS/Labs	
SBP	
DBP	
HR	
RR	

EPIT1

Pulse Ox	
Na	
K	
glucose	
HgB	
Hct	
PT/ INR	
Creatinine	

Medical History

Cardiovascular:	☐ HTN ☐ CAD ☐ MI ☐ CHF ☐ CABG ☐ PCI ☐ PVD ☐ EF ☐ Pacemaker ☐ Valve Disease ☐ Arrythmia ☐ Hyperlipidemia ☐ None of the above ☐ Other
Cardiac Cath (results)	
Cardiac Stress Test: Date & Results	
PCI Vessel (other)	
Pulmonary Disease	☐ Smoker

EPITT

	☐ Former smoker ☐ COPD ☐ Asthma ☐ Recent URI ☐ Resp Failure ☐ Other ☐ none ☐ h/o TB ☐ Bronchitis
Stop Bang >3	○ Yes ○ No reset
Sleep Apnea * must provide value	○ Yes ○ No reset
GI	☐ GERD/ Hiatal hernia ☐ Bowel Obs ☐ Morbid Obesity ☐ GI bleed ☐ PONV ☐ Other (specify) ☐ None
Renal/ Endocrine	☐ Diabetes ☐ Thyroid (hyperthyroid or hypothyroid) ☐ ESRD ☐ Renal Insuff ☐ CKD ☐ Other (specify) ☐ None
Neuro	☐ CVA ☐ TIA ☐ Neuromuscular disease ☐ Spinal Cord Compression ☐ Seizures ☐ other ☐ none
Hematology/Oncology	☐ Cancer

EPITI

* must provide value

- [ ] Anemia
- [ ] Thrombocytopenia
- [ ] Sepsis
- [ ] Coagulapathy
- [ ] Refuses blood products
- [ ] other
- [ ] none

HIV/Hepatitis A, B C

* must provide value

- [ ] Hepatits A
- [ ] Hepatitis B
- [ ] Hepatitis C
- [ ] HIV
- [ ] none of the above

Infectious Disease

- [ ] MRSA
- [ ] VRE
- [ ] TB
- [ ] C-diff
- [ ] Droplet précautions
- [ ] Other

LMP:

Today M-D-Y

ETOH

- ○ Yes
- ○ No

reset

Recreational Drugs

- [ ] Marijuana
- [ ] Cocaine
- [ ] PCP
- [ ] Crystal Meth
- [ ] Other (describe)

Intra-OP

ASA class

- [ ] I
- [ ] II
- [ ] III
- [ ] IV

Airway management

- [ ] ETT
- [ ] DLT

EPITI

	☐ Bronchial Blocker ☐ LMA ☐ Difficult Airway ☐ Other ☐ none
Inhalantion agent	○ Desflurane ○ Sevoflurane ○ Isoflurane ○ None reset
Sedatives/ Anxiolytics	☐ Versed ☐ Ativan ☐ None ☐ Other
Narcotics	☐ Fentanyl ☐ Remifentanil ☐ Sufentanil ☐ Dilaudid ☐ Morphine ☐ Demerol ☐ Ketamine ☐ None
Tylenol (IV) mg	
Lidocaine (IV ERAS Protocol) mg:	
Muscle Relaxant	☐ Succinylcholine ☐ Rocuronium ☐ Vecuronium ☐ Cis-atracurium ☐ Atracurium ☐ None ☐ Other
Regional Anesthesia	○ Yes ○ No reset

EPITI

Intra-op Vasopressors:	☐ Phenylephrine ☐ Epi ☐ Norepi ☐ Dobutamine ☐ Ephedrine ☐ Other ☐ None
Intra-op Antihypertensives	☐ Metoprolol ☐ Labetalol ☐ Hydralazine ☐ Nitro ☐ Nipride ☐ Cardizem ☐ Other ☐ None
Blood Products	○ PRBCs ○ FFP ○ Cryoprecipitate ○ Factors VII ○ Transaxemic Acid ○ None
Reversals	☐ Neostigmine ☐ Robinul ☐ None
Antiemitics	☐ Zofran ☐ Reglan ☐ Phenergan ☐ Protonix ☐ Decadron ☐ Pepcid ☐ Scopolamine patch ☐ Other ☐ None
Antibiotics (last dose) * must provide value	☐ Ancef 1 gram ☐ Ancef 2 grams ☐ Cipro 400 mh ☐ Vancomycin 500 mg

	☐ Vancomycin 1 gram ☐ Vancomycin 1.5 grams ☐ Tobrabycin 80 mg ☐ Gentamycin 80 mg ☐ Gentamycin 100mg ☐ Flagyl 500 mg ☐ Clindamycin 900 mg ☐ Other (specify) ☐ none
Last dose of Antibiotics	Now M-D-Y H:M
IV Fluid Crystalloids/ Colloids	☐ LR ☐ 0.9% ☐ D 5 1/2 NS ☐ D50 ☐ Albumin 5% ☐ Albumin 25%
Total IVF	
EBL (ml):	
Urine output (mL)	
Other Info	
Extubated	☐ Yes ☐ No
Is the patient on the correct bed?	○ Yes ○ No
Post-op Anesthesia Orders Complete	○ Yes ○ No

EPITI

Vasopressors/ Antihypertensives available?	○ Yes ○ No	reset
Narcotics with anesthesia provider?	○ Yes ○ No	reset

https://redcap.musc.edu/surveys/?s=CXHA3HEMWE[10/19/16, 7:53:43 AM]

Appendix L. Invitation to participate in pilot testing the EPITI; Manuscript III

May 3, 2016

Hi Everyone,

I received a generous grant to conduct research on post op handovers. My research will pilot test an electronic handover instrument and we need volunteers to assist with pilot testing:

What you'll need to do:

- Reference an electronic handover form when you transfer your patient to the PACU nurse. The form will have pre- op patient history, intra op info and post op planning. Either myself or a research assistant will assist with entering the info.
- Complete a short electronic survey
- Participate in a focus group to discuss your experiences (refreshments provided)
- Approximately 3 handovers per provider

Incentives:

- $100 gift card to pilot test the electronic instrument and complete a survey
- $25 gift card to participate in a focus group
- Your name entered in a drawing for a chance to win an iPad

Timeframe:

Should take about 3 months to collect data

Please let me know if you can assist with data collection
monica.w.rose@MedStar.net I'd like to start ASAP

Sincerely,

Monica W Rose

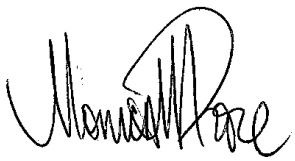
Appendix M. Invitation to participate in focus groups and survey; Manuscript III

Dear Colleagues

Thank you for pilot testing the electronic post operative handover instrument. Your time and effort is greatly appreciated. We would like to assemble two focus groups; an anesthesia provider focus group and a separate PACU nurse focus group to discuss your experience with incorporating the electronic post operative handover instrument into your practice. Your participation in either the anesthesia provider focus group or PACU nurse focus group is strictly voluntary. There is no penalty for not participating and we anticipate minimal risks to individuals who assemble to discuss their experience with the electronic instrument. Declining to participate in focus group discussions will have no effect on your work. We will collect no identifying information and your responses/ discussions will be kept on a password protected digital recorder. A professional transcriptionist will transcribe focus group discussions and the transcriptionist will be directed to delete any identifying information. Data obtained from recordings will be analyzed in aggregate.

Once again, thank you very much for pilot testing the electronic post operative handover instrument. Please contact the PI, Monica Rose, monica.w.rose@medstar.net, to participate in focus group discussion.

Sincerely,



Monica W Rose, MSN CRNA

Medstar Washington Hospital Center

Department of Anesthesiology

Appendix N.

(a) Interview guide for focus groups and semi-structured interviews; Manuscript III
(b) Anesthesia provider and PACU nurse feasibility surveys; Manuscript III

Assessing Post-operative Information Transfers: A pilot and feasibility study - Rose

Focus Group Protocol/ Questions

1. Describe how post-op handovers were improved by incorporating the electronic post-operative information transfer instrument (EPITI).
2. Describe instances where incorporating the EPITI into post-op handovers was burdensome.
3. Describe some of the operational/ user concerns with using an electronic post-operative information transfer instrument.
4. How did using the EPITI improve or hinder communication between anesthesia providers and post-anesthesia care unit (PACU) nurses?

EPITI Provider demographics

Please complete the survey below.

Thank you!

Type of provider	○ MD ○ CRNA ○ AA-C ○ PACU nurse
Gender	☐ Female ☐ Male
Age (years)	_____
Race	○ African American/Black ○ White ○ Asian ○ American Indian ○ Native Hawaiin/ Pacific Islander ○ Other:
Race (other, please specify)	_____
Years in practice	_____
Overall, I am satisfied as an anesthesia provider or PACU nurse with implementing the EPITI (electronic instrument) into current practice.	○ Strongly disagree ○ Disagree ○ Somewhat disagree ○ Neutral ○ Somewhat agree ○ Agree ○ Strongly agree
During handovers, the EPITI is easy to review while maintaining vigilance over the patient.	○ Strongly disagree ○ Disagree ○ Somewhat disagree ○ Neutral ○ Somewhat agree ○ Agree ○ Strongly agree
It is necessary to organize my time differently when using the EPITI during handovers when compared to paper charting.	○ Strongly agree ○ Agree ○ Somewhat agree ○ Neutral ○ Somewhat disagree ○ Disagree ○ Strongly disagree
Reviewing the EPITI during handovers was inconvenient and distracting.	○ Strongly agree ○ Agree ○ Somewhat agree ○ Neutral ○ Somewhat disagree ○ Disagree ○ Strongly disagree

The EPITI met my information needs during the handover process.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Somewhat disagree
- ◯ Neutral
- ◯ Somewhat agree
- ◯ Agree
- ◯ Strongly agree

Communication among anesthesia providers and PACU nurses improved while implementing the EPITI.

- ◯ Strongly agree
- ◯ Agree
- ◯ Somewhat Agree
- ◯ Neutral
- ◯ Somewhat disagree
- ◯ Disagree
- ◯ Strongly disagree

The purpose of the EPITI was to serve as an interface and as an electronic instrument to facilitate communication during post-operative handovers. The EPITI was implmented as intended.

- ◯ Strongly agree
- ◯ Agree
- ◯ Somewhat agree
- ◯ Neutral
- ◯ Somewhat disagree
- ◯ Disagree
- ◯ Strongly disagree

Overall, I feel near misses, meaning adverse events that could have happened but were avoided, could be decreased by formally implemenmting an electronic handover form.

- ◯ Strongly agree
- ◯ Agree
- ◯ Somewhat agree
- ◯ Neutral
- ◯ Somewhat disagree
- ◯ Disagree
- ◯ Strongly disagree

I am satisfied with the information content of the EPITI

- ◯ Yes
- ◯ No

If no, what changes would you make to the EPITI? Please describe:

_____

I received enough training and orientation to the electronic instrument PRIOR to implementing the instrument into practice.

- ◯ Strongly agree
- ◯ Agree
- ◯ Somewhat agree
- ◯ Neutral
- ◯ Somewhat disagree
- ◯ Disagree
- ◯ Strongly disagree

What effect did using the EPITI have on your usual routine during handovers?

_____

After pilot testing the EPITI, I perceive that the EPITI has the potential to improve patient safety.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Somewhat disagree
- ◯ Neutral
- ◯ Somewhat agree
- ◯ Agree
- ◯ Strongly Agree

The EPITI facilitated the communication of patient information during handovers.

- ◯ Strongly agree
- ◯ Agree
- ◯ Somewhat agree
- ◯ Neutral
- ◯ Somewhat disagree
- ◯ Disagree
- ◯ Strongly disagree

The format of the EPITI was easy to follow during handovers.

- ◯ Strongly agree
- ◯ Agree
- ◯ Somewhat agree
- ◯ Neutral
- ◯ Somewhat disagree
- ◯ Disagree
- ◯ Strongly disagree

Additional comments:

Appendix O. Odds ratio for pain scores>5 on arrival to PACU; Manuscript III

EPITI * Pain score > 5 Cross tabulation

			Pain score		
			No	Yes	Total
EPITI	Pilot	Count	235_a	93_b	328
		Expected Count	224.6	103.4	328.0
		% within EPITI	71.6%	28.4%	100.0%
		% within Pain score	66.4%	57.1%	63.4%
		% of Total	45.5%	18.0%	63.4%
	Pre pilot	Count	119_a	70_b	189
		Expected Count	129.4	59.6	189.0
		% within EPITI	63.0%	37.0%	100.0%
		% within Pain score	33.6%	42.9%	36.6%
		% of Total	23.0%	13.5%	36.6%
Total		Count	354	163	517
		Expected Count	354.0	163.0	517.0
		% within EPITI	68.5%	31.5%	100.0%
		% within Pain score	100.0%	100.0%	100.0%
		% of Total	68.5%	31.5%	100.0%

Each subscript letter denotes a subset of Pain score categories whose column proportions do not differ significantly from each other at the .05 level.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.188[a]	1	.041	.049	.026
Continuity Correction[b]	3.795	1	.051		
Likelihood Ratio	4.144	1	.042	.049	.026
Fisher's Exact Test				.049	.026
N of Valid Cases	517				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 59.59.
b. Computed only for a 2x2 table

Risk Estimate

	Value	95% Confidence Interval Lower	Upper
Odds Ratio for EPITI (Pilot / Pre pilot)	1.486	1.016	2.175
For cohort Pain score = No	1.138	1.000	1.294
For cohort Pain score = Yes	.766	.594	.986
N of Valid Cases	517		

Appendix P. Odds ratio for completed PACU orders; Manuscript III

EPITI * PACU orders (complete) Cross tabulation

			PACU orders		
			No	Yes	Total
EPITI	Pilot	Count	15	310	325
		Expected Count	55.1	269.9	325.0
		% within EPITI	4.6%	95.4%	100.0%
		% within PACUorders	13.8%	58.1%	50.5%
		% of Total	2.3%	48.2%	50.5%
	Pre pilot	Count	94	224	318
		Expected Count	53.9	264.1	318.0
		% within EPITI	29.6%	70.4%	100.0%
		% within PACUorders	86.2%	41.9%	49.5%
		% of Total	14.6%	34.8%	49.5%
Total		Count	109	534	643
		Expected Count	109.0	534.0	643.0
		% within EPITI	17.0%	83.0%	100.0%
		% within PACUorders	100.0%	100.0%	100.0%
		% of Total	17.0%	83.0%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	71.039[a]	1	.000	.000	.000
Continuity Correction[b]	69.278	1	.000		
Likelihood Ratio	77.608	1	.000	.000	.000
Fisher's Exact Test				.000	.000
N of Valid Cases	643				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 53.91.
b. Computed only for a 2x2 table

Risk Estimate

	Value	95% Confidence Interval Lower	Upper
Odds Ratio for EPITI (Pilot / Pre pilot)	.115	.065	.204
For cohort PACUorders = No	.156	.093	.263
For cohort PACUorders = Yes	1.354	1.256	1.460
N of Valid Cases	643		

Appendix Q. American Association of Nurse Anesthetists Doctoral Fellowship Award Letter

AANA Foundation reference number: 2016-F-2
RESPONSE REQUIRED

Dear Monica Rose:

Congratulations! On behalf of the American Association of Nurse Anesthetists Foundation, I would like to inform you that you have been named a *2016 AANA Foundation Doctoral Fellow* of the AANA Foundation for your project titled "ASSESSING POST-OPERATIVE INFORMATION TRANSFERS: A pilot and feasibility study." With the prestige of this award comes a cash award of up to $10,000.

The AANA Foundation Doctoral Fellowship Program is designed to cultivate the development of leaders within the nurse anesthesia specialty, currently engaged in doctoral studies. You have demonstrated a strong commitment to research, and the AANA Foundation Board of Trustees proudly bestows upon you this honor. Based on your accomplishments to date, you have met the goal of the AANA Foundation Doctoral Fellowship Program with your desire to develop a strong program of research and evidence based study. This was the eleventh year the AANA Foundation awarded the honor of AANA Foundation Doctoral Fellow. The number of applications rose with a high caliber of quality in all the applications.

You will be presented with this award at the Awards and Recognition Event at the AANA 2016 Nurse Anesthesia Annual Congress in Washington DC in September. This summer, you will receive a separate invitation to this prestigious event for you and a guest.

Please review the requirements in the documents below, sign and return to us so we may begin to process your account. **Your AANA Foundation reference number for this project is 2016-F-2. You must include this number on all future correspondence.**

Please immediately download and retain the following forms from Dropbox (instructions below): Check request, W-9, recipient agreement, applicant statement, project budget template and sample, progress report form, amendment request, program policy, and final financial report guidelines. All reimbursement forms must include the same "make check payable to" information for payments (i.e., if your university will receive your funds, provide a W-9 for the university and include only their address information on each form.)

We have your original budget on file. If you have been notified that your budget was revised by the Foundation or if you have changes, you must submit an updated budget using the budget

template. We must have your approved IRB/IACUC form or exemption (or attestation that IRB is non-applicable) before issuing funds. Awardees must provide evidence of IRB/IACUC approval/exemption within 12 months of receipt of this funding notice (**3/25/17**). When presenting your results, you must recognize funding from the AANA Foundation.

Presentation travel: We encourage you to apply for oral poster presentation at the AANA Annual Congress. If accepted for oral presentation, travel funds will only be reimbursed through the Poster Program, not the Fellowship Program. However, the Foundation invites you to apply for additional funding to present your findings at professional meetings. This funding is in addition to your award amount (one time application per person, up to $1,000). We realize this stipend may only partially cover your travel expenses. To apply for this funding through the Fellowship Program, you must submit the presentation travel request form, written evidence of presentation acceptance, and a program from the meeting. Duplicate travel funding is not permissible if covered by your university or affiliate. Funding is approved only as the balance of the Foundation's travel budget permits. If travel is approved, you will receive our travel policy and expense report. Approved applicants must comply with our travel policy.

All funding requests must appear in your final budget, or be approved by the Executive Director if there is a special circumstance. **You must submit an annual progress report (using the progress report form) on December 15 until your project is complete.** All funds must be expended by June 30, 2017; unexpended funds must be returned to the Foundation by July 30, 2017. A final progress report form, the "Guidelines Financial Report" document and project budget form are due **no later than July 30, 2017.** If you are unable to meet the expected deadlines, a formal request for an extension must be submitted using the amendment form provided.

Please complete your initial paperwork and send in ***one email*** to foundation@aana.com (with subject line: AANA Foundation Fellowship) by ***April 15***.

Upon completion of your research, the Foundation requires a copy of the final abstract. Please email it to foundation@aana.com and post it on our Research Abstract Repository at http://www.aana.com/resources2/research/Pages/Research-Abstract-Repository.aspx.

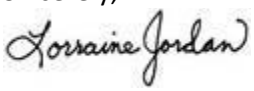
We strongly encourage you to share your research endeavors with our colleagues to help forward the future profession of nurse anesthesia. Please visit www.aanafoundation.com in the spring to apply for the AANA Oral and General Poster Session at the AANA Annual Congress. In addition, we invite you to submit your final abstract to us for consideration in the AANA NewsBulletin, "Discoveries of Distinction."

Finally, before we issue initial funds, please submit a professional looking headshot that is at least 2 MB for promotional purposes, a short summary of your work in progress to date (1-2

sentences) and a statement about your gratitude to the AANA Foundation (1-2 sentences) for the support of your research (for potential promotional purposes).

Again, my congratulations to you! The Foundation Board of Trustees appreciates the time and effort you dedicated to developing this proposal. If we can be of further assistance, please feel free to contact me at ljordan@aana.com or 847-655-1172.

Sincerely,



Lorraine M. Jordan, PhD, CRNA, CAE, FAAN
Senior Director of Research and AANA Foundation CEO

P.S. Attached are unedited verbatim comments from the reviewers about your proposal.

Checklist of items to complete and return prior to receiving your initial funding: (Please submit all initial paperwork by April 15 to foundation@aana.com (see exceptions below [1, 2])).

- Check request
- W-9
- Recipient agreement
- Applicant statement
- Project budget (if changes have been made since application online. If there are no changes, please notify us.)
- Progress report form (indicate current date and project status) [1]
- Approved IRB/IACUC form or exemption (or attestation that IRB/IACUC is non-applicable) [2]
- Headshot (optional) at least 2 MB. (If you do not wish to provide a photo, please notify us immediately.)
- Short summary of your research progress (i.e., a short abstract to date—1-2 sentences in a Word document)
- Statement of gratitude in a Word document

[1] Only submit this form at this time if you are requesting funds, and provide your IRB/IACUC approval/exemption.

[2] IRB/IACUC approval/exemption must be received before fund distribution, within 12 months of receipt of this notice. If you plan to submit this document to us at a later date, please indicate when.

Checklist of items to complete and return every December 15 until project is complete:

- Progress report form (indicate current date and project status)

Checklist of items to complete and return for the final report at the end of your research:

- Progress report form (indicate current date and project status)
- Final project budget
- Guidelines Final Financial Report

Dropbox instructions (Download all documents immediately):

To view the documents on Dropbox.com, visit the link below and click download (then download as zip) in the top right corner. You may need to tell your browser to allow the page to load and/or allow time for the software to "generate a preview." (You shouldn't have to sign up for an account to see the files.)

https://www.dropbox.com/sh/8s1k33ywi6vkjzm/AADjfSdEsmvfOInm8Uw8INgqa?dl=0

**The AANA Foundation does not provide funding for tuition, university fees, educational resources, researcher's salary/benefits, or travel (see exception above for separate travel funding

Appendix R. AORN/CCI PhD Grant Award Letter

AORN
Association of periOperative Registered Nurses
2170 South Parker Road, Suite 300 Denver, CO 80231-5711 (303) 755-6300 or (303) 755-6304 http://www.aorn.org/

Date 5/2/16

Dear Monica Rose,

We are pleased to inform you that your project has been chosen to receive the AORN/CCI PhD grant.

The funds are to be used over the period June 2016 to June 2017, in accordance with the budget you submitted.

We would like to receive quarterly updates on your project and you will be expected to submit your research and results to the AORN Journal for publication upon completion. Your check is forthcoming soon!

Our best wishes in carrying out this important work!

Sincerely,

Lisa Spruce, RN, DNP, CNS-CP, ACNS, ACNP, CNOR, FAAN
Director, Evidence-Based Perioperative Practice
Association of periOperative Registered Nurses

On behalf of AORN and CCI, Congratulations!