Standardizing Intraoperative Handoffs amongst Certified Registered Nurse Anesthetists

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Standardizing Intraoperative Handoffs Amongst Certified Registered Nurse Anesthetists

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Version Date: March 05, 2022
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Abstract

**Background and Review of Literature:** Communication errors are a leading cause of preventable medical errors and inadequate handoffs have been linked to sentinel events. Research has shown that standardizing handoff processes can reduce errors, improving patient safety, and resulting in other positive outcomes including increased staff satisfaction, without impacting handoff duration.

**Purpose:** The purpose of this project was to determine how the implementation of a standardized handoff tool would impact perceptions of handoff communications, retention of important patient information relayed during handoffs, staff satisfaction, and handoff duration.

**Implementation Plan and Methods:** Information regarding use of the tool was sent to Certified Registered Nurse Anesthetists via e-mail and was also on flyers posted in anesthesia work spaces. Further education was provided prior to intraoperative handoff assessments if necessary. A pre-implementation survey was administered to assess perceptions of current handoff processes. A prospective, observational assessment was then performed to assess the relaying and retention of patient information between Certified Registered Nurse Anesthetists both prior to and after implementation of a standardized handoff tool. These handoffs were timed to measure duration. A post-handoff assessment was administered to further assess information retention. Finally, a post-intervention survey was administered for comparison to the pre-intervention survey. Results were analyzed to determine next steps.

**Implications/Conclusion:** Significant adverse events including death may occur as a result of inadequate intraoperative handoffs. Anesthesia providers at Barnes-Jewish Hospital have the potential to implement a simple, low-cost, evidence-based intervention that can help curb the
occurrence of these events, thus avoiding patient harm while also reaping the benefits of increased provider satisfaction and potentially decreased costs.

*Keywords:* handoff, standardized handoff, CRNA handoff, anesthesia handoff, handoff tool, intraoperative handoff, intraoperative care transitions, anesthetic handover, intraoperative handover, and anesthesia
Standardizing Intraoperative Handoffs Amongst Certified Registered Nurse Anesthetists

Shift relief and break handoffs, also referred to as handovers or transitions of care, involve transferring vital information and responsibility from one clinician to another. Effective handoffs are necessary for ensuring patient safety and quality of care. With over 300 million surgical procedures being performed worldwide each year, these handoffs often occur between anesthesia clinicians in the operating room (OR), which is by nature a high-risk patient care environment (Nepogodiev et al., 2019). Evidence shows that using standardized checklists and/or structured handoff processes increases the accuracy of information transfer, increases staff perceptions of the quality of handoff, and decreases adverse events without negatively impacting handoff time (Agarwala et al., 2015; Anastasian et al., 2016; Canale, 2018; Epstein et al., 2017; Hudson et al., 2015; Hyder et al., 2016; Jayaswal et al., 2011; Jones et al., 2018; Jullia et al., 2017; Lee et al., 2019; Liu et al., 2019; Saager et al., 2014; Wright, 2013).

Background

Transferring patients between Certified Registered Nurse Anesthetists (CRNAs) during both temporary (i.e., relief breaks where the original clinician returns within a pre-specified period of time) and permanent (i.e., where the original clinician does not return for continued anesthesia care, such as at the end of a shift) transitions requires a handoff communication. Handoff is defined as the transfer and acceptance of patient-specific information from one healthcare provider to another, or from one team of caregivers to another, in order to ensure safety in the continuity of care. During handoffs, the off-going CRNA gives a verbal (and sometimes written) report to the receiving CRNA that includes important details regarding the patient’s medical history, his/her surgery, any pertinent intraoperative events, and the postoperative plan. The off-going CRNA then leaves, and care is assumed by the receiving
clinician. Though healthcare providers in all specialties may put great effort into achieving a thorough handoff, handoffs are considered high-risk communications due to the possibility that gaps, omissions, and errors may occur or receiving staff expectations may not be met, which can further result in patient harm, sentinel events, and decreased staff satisfaction (The Joint Commission, 2017).

Contributing factors to inadequate handoffs include insufficient or misleading patient information, an absence of safety culture, lack of time, interruptions and distractions during the report, ineffective communication methods, and lack of standardized procedures. Sentinel events that have resulted from inadequate handoff communications include falls, delays in care and treatment, medication errors, and even wrong-site surgeries (The Joint Commission, 2017). Other consequences include increased wait times, increased readmissions, increased lengths of stay, increased healthcare costs, missed diagnoses, unnecessary testing, and increased malpractice claims (Alimenti et al., 2019).

**Problem Statement**

Shift break regulations in many states coupled with standard shift changes lead to required patient handoffs (United States Department of Labor, 2021). It is clear that the quality of patient handoffs is critically important for ensuring patient safety. Evidence shows that using standardized checklists and/or structured handoff processes increases the accuracy of information transfer, increases staff perceptions of the quality of handoff, and decreases adverse events (Gagnier et al., 2016; Lane-Fall et al., 2018). A quality improvement (QI) project focused on incorporating a standardized handoff tool into the electronic health record (EHR) for CRNAs to utilize during intraoperative transitions is a simple, efficient, and cost-effective way to address this problem.
Organizational “Gap” Analysis of Project Site

Data regarding communication errors, or more specifically, communication errors that occur during handoffs at a tertiary center in the Midwest, have not been quantified. However, in the hospital’s 2017 Patient Safety & Quality Annual Report, it is noted that the results of the Culture of Safety Survey indicated room for improvement with communication (Barnes-Jewish Hospital, 2017). Several prominent anesthesia groups support the mission of standardizing patient handoffs (Department of Defense, 2005; The Joint Commission, 2017; Multi-Center Handoff Collaborative, n.d.). In general, implementing evidence-based practices can help hospitals meet benchmark patient safety goals and even surpass them (Agency for Healthcare Research and Quality, 2019). Though standardizing intraoperative handoffs between CRNAs has the potential to substantially improve patient safety, decrease costs, and increase staff satisfaction, no standardized intraoperative handoff tool or checklist was available for use at this hospital (The Joint Commission, 2017).

PICOT Question

The clinical question for this project was: in the intraoperative setting, can implementation of and adherence to a standardized patient handoff tool (I) compared to no standardized tool (C) improve perceptions of CRNA-CRNA handoff communication for surgical patients (P), increase receiving staff satisfaction, decrease omission of important patient details, and maintain or reduce the duration of handoffs (O) over a two-month trial period (T)?

Significance

In the United States, an estimated 4,000 handoffs, or care transitions, occur daily within academic teaching hospitals, which totals to nearly 1.5 million handoffs per facility per year (The Joint Commission, 2017). At this Midwest hospital in 2017, there were 22,813 outpatient
surgeries and 18,680 inpatient surgeries conducted, for a minimum of 41,493 anesthesia handoff reports (Barnes-Jewish Hospital, 2017). Though facilities may attempt to limit the number of handoffs that occur each day, it is not possible for one provider to stay with a patient at all times. CRNAs may need to hand off a patient to a different anesthesia provider in the middle of a case.

As we learned from the Institute of Medicine’s landmark report, *To Err Is Human*, 44,000-98,000 people die in the United States every year from preventable medical injuries (Institute of Medicine, 2000). Additionally, it has been estimated that 80% of serious medical errors occur as a result of miscommunications during the transfer of patients (The Joint Commission, 2012). A study released in 2016 on medical malpractice cases reflecting data from over 400 hospitals across the United States showed that communication failures were a factor in 30% of malpractice cases, or a total of 7,149 cases, filed between the years 2009-2013. Of these cases, 27% involved surgeries, and 46% involved other services, including anesthesia. Consequently, 1,744 of the cases resulted in death, and the total financial loss incurred was $1.7 billion. For individual hospitals, it is estimated that an average 500-bed hospital loses $4 million every year from communication inefficiencies (CRICO Strategies, 2016).

Outside of the patient harm and financial costs associated with inadequate handoffs, studies have been conducted regarding staff satisfaction involving patient handoffs. Some factors that have been found to negatively influence perceptions of handoff communications include the absence of consistency and structure, too much information, too little information, inconsistent quality, and the time required to take handoffs. However, in multiple studies, increased satisfaction was expressed after the implementation of a standardized handoff tool (Canale, 2018; Galatzan & Carrington, 2018). For example, Canale’s 2018 study utilizing a standardized handoff tool resulted in a 50% increase in CRNAs who strongly agreed they were satisfied with
standardized handoffs after they were implemented. Additionally, staff participants in Gagnier et al.’s 2016 study were found to be more satisfied with the new handoff tool than any prior methods and stated they would be even more willing to use the tool if it was integrated into the EHR. Likewise, in Dixon et al.’s 2015 study, providers’ perspectives and satisfaction with the handoff process significantly improved after implementation of a standardized handoff process on 19 out of 22 survey items (P < .001).

Goals, Objectives, and Expected Outcomes

The goal of this QI project was to improve handoff communication amongst CRNAs during permanent care transitions through the use of a standardized handoff tool that was incorporated into the EHR. After an initial, short email focused on where to access the tool and how to use it, providers were encouraged to use the tool throughout the study period. Pre- and post-intervention surveys, as well as handoff observations, occurred to measure study outcomes, which were expected to include improved perceptions of CRNA to CRNA handoff communications, increased staff satisfaction, and decreased omission of important patient details, along with no significant changes in handoff time.

Review of the Literature

Using keywords and phrases, including handoff, standardized handoff, CRNA handoff, anesthesia handoff, handoff tool, intraoperative handoff, intraoperative care transitions, anesthetic handover, intraoperative handover, and intraoperative AND handoff AND anesthesia, peer-reviewed articles were analyzed from the available literature. Databases utilized include PubMed, CINAHL Complete, Clinicaltrials.gov, MEDLINE Complete, National Quality Measures Clearinghouse, the Centers for Disease Control and Prevention, and the World Health Organization.
Evidence was limited to those articles which were published in the English language within the past 10 years. The population of patients being studied consisted of adults undergoing any type of surgery. Anesthesia providers studied included residents, fellows, anesthesiology attendings, CRNAs, and Student Registered Nurse Anesthetists (SRNAs). In studies that developed an intervention, all comparison groups were included, along with all outcomes.

A large pool of results came from these searches. After eliminating duplicates, 16 articles met inclusion criteria. Of these 16 articles, eight were retrospective cohort studies that involved the investigators examining electronic health records for morbidity and mortality complications related to intraoperative handovers. Six studies were prospective studies that assessed the effects of implementing standardized handoff tools during intraoperative handoffs. The final two studies, although they met inclusion criteria, were systematic reviews that evaluated the included studies and thus were ultimately excluded as each of these seven articles were analyzed individually (Abraham et al., 2021; Hu et al., 2020).

**Informal Handoffs and Adverse Outcomes**

In eight retrospective cohort studies (level II evidence, level A-B quality), seven found positive correlations between a wide variety of adverse outcomes and multiple or unstructured intraoperative anesthesia handoffs (Anastasian et al., 2016; Epstein et al., 2017; Hudson et al., 2015; Hyder et al., 2016; Jones et al., 2018; Liu et al., 2019; Saager et al., 2014). Studies varied by their evidence quality and specific dependent variables. Several studies concluded that a structured process or checklist for handoffs may improve outcomes. Adverse outcomes included morbidity, mortality, increased hospital lengths of stay, hospital readmissions, and documentation errors.
Morbidity and Mortality

Anastasian et al. (2016) reviewed all general anesthesia cases at their institution over the past five years that required endotracheal intubation, excluding cases that would normally require extended postoperative intubation. Of the 37,824 cases included in their study, 2,033 patients were not extubated in the OR after completion of their surgeries. Their study showed that cases with an intraoperative anesthesia attending handoff had a greater risk of delayed extubation, and that as the total number of anesthesia attendings involved in a case increased, the risk of delayed extubation also increased (Anastasian et al., 2016).

Hudson et al. (2015) studied the effects of anesthesia handovers on postoperative morbidity and mortality following cardiac surgeries. Postoperative morbidity included postoperative myocardial infarctions, cerebral vascular accidents, prolonged mechanical ventilation (greater than 48 hours), and acute kidney injury requiring renal replacement therapy. The investigators found that, overall, surgeries that involved anesthesia handovers were associated with a 27% greater risk of morbidity and a 43% greater risk of in-hospital mortality. Additionally, the investigators noted that utilizing handover tools can improve communication during handover, and thus stated that their next study will involve implementing a handover tool into the EHR to see if it positively impacts morbidity and mortality (Hudson et al., 2015).

In a third study, Hyder et al. (2016) studied anesthesia handoffs during elective colorectal surgeries. They found that one or more additional attending anesthesiologist(s) were associated with an increased risk of postoperative complications for up to 30 days, including both nonfatal complications and death. Nonfatal complications studied included acute renal failure, bleeding that required blood transfusions of four or more units of packed red blood cells, cardiac arrest requiring cardiopulmonary resuscitation, coma lasting 24 hours or more, myocardial infarction,
unplanned intubation, ventilator use for greater than 48 hours, pneumonia, stroke, wound
disruption, surgical site infections, sepsis, septic shock, and systemic inflammatory response
syndrome. Hyder and colleagues suggested that future studies should focus on the impact of
intraoperative handoff checklists on patient outcomes (Hyder et al., 2016).

A fourth study by Liu et al. (2019) evaluated the effects of permanent intraoperative
anesthesia handoffs during noncardiac surgeries on the incidence of developing postoperative
delirium within seven days of surgery. Secondary outcomes studied included major
complications within 30 days of surgery (defined as new onset complications other than delirium
that affected recovery and required treatment). After controlling for confounders, it was
determined that intraoperative anesthesia handoffs were associated with an increased risk of
postoperative delirium, as well as a higher incidence of non-delirium complications. However, it
is noted that while it has been shown that quality handovers can be achieved utilizing protocols
and checklists, the impacts of these standardized handoff methods have not been studied in
regards to postoperative delirium (Liu et al., 2018).

Saager et al. (2014) analyzed the effect of intraoperative anesthesia handoffs during
noncardiac surgeries on postoperative morbidity (defined as serious cardiac, respiratory,
gastrointestinal, urinary, bleeding, and infections complications) and mortality. They also studied
the effects of an increased number of handoffs during the same surgery. A difference in their
study was they looked at effect size differences amongst attendings, residents, and CRNAs. Their
primary result was that each anesthesia handoff increased the risk of composite outcome (in-
hospital mortality and serious complications) by 8%. They also found that increasing the number
of intraoperative handoffs increased the likelihood of developing serious complications and
mortality; for example, patients are 1.08 times more likely to develop serious complications per
transition. Similarly, two transitions were $1.08^2$, or 1.17 times more likely, and so forth. Finally, they found no differences amongst different types of anesthesia providers (Saager et al., 2014).

A final supporting study by Jones et al. (2018) looked at the effect of intraoperative anesthesia handoffs on major postoperative complications within 30 days and all-cause death. Surgery types included neurosurgeries, cardiac, vascular, thoracic, and abdominal surgeries that lasted over two hours and required at least one night of hospitalization. An interesting finding of their study was that as the years being studied progressed, the percentage of patients that underwent surgeries involving anesthesia handoffs increased. This was likely due to the implementation of policies requiring mandatory breaks and restricting duty hours. The investigators of this study implied that an improved handover process involving mandated checklists would eliminate patient harm while continuing to allow for clinician breaks and shift changes (Jones et al., 2018).

Conversely, Terekhov et al. (2016) studied the association between anesthesia handovers and postoperative complications and mortality and found differing results. All surgery types were studied and after controlling for confounding variables, the investigators concluded that anesthesia care transitions were not associated with an increased risk of adverse postoperative outcomes and mortality (Terekhov et al., 2016).

**Hospital Length of Stay and Readmission Rates**

In addition to morbidity and mortality consequences, Jones et al. (2018) and Liu et al. (2019) also looked at the effect of intraoperative anesthesia handoffs on hospital readmission rates. Jones et al. found that mean hospital length of stay and incidence of postoperative intensive care unit admissions were increased in patients who underwent a complete handover. However, an association with hospital readmission rates was not found to be significant (Jones et
al., 2018). Liu et al. also concluded that patients associated with complete intraoperative anesthesia handoffs had longer hospital stays (Liu et al. 2018).

**Documentation Errors**

Epstein et al. (2017) looked at the incidence of documentation errors involving controlled drugs in the setting of all surgeries involving a permanent intraoperative anesthesia handoff. The influence of a number of covariates was evaluated using regression models. Despite the construction of these models, cases involving intraoperative anesthesia handoffs were still found to be associated with higher controlled drug documentation discrepancy rates. The investigators suggested that a formal, structured handoff process might be useful (Epstein et al., 2017).

Although seven out of eight of the previous studies found intraoperative handoffs were associated with adverse postoperative outcomes, a common theme that was mentioned amongst the investigators was that utilizing a structured or standardized handoff process could decrease these adverse outcomes and improve documentation accuracy (Epstein et al., 2017; Jones et al., 2018; Liu et al., 2018; Hudson et al., 2015; Hyder et al., 2016).

**Benefits and Acceptance of Standardized Handoffs**

Six prospective studies incorporated a standardized handoff intervention in an attempt to improve intraoperative handoffs between anesthesia providers. One study by Jayaswal et al. (2011) utilized an electronic handoff protocol, while the other five studies utilized checklists. Of these checklists, two were paper (Jullia et al., 2017; Wright, 2013), three were electronic (Agarwala et al., 2015; Jayaswal et al., 2015; Lee et al., 2019), and one did not specify the checklist medium (Canale, 2018). Studies also differed in the clinicians involved; handoffs between residents and CRNAs (Jullia et al., 2017), residents and SRNAs (Lee et al., 2019), CRNAs only (Canale, 2018; Wright, 2013), and a mixture of providers such as residents,
fellows, CRNAs, and attending anesthesiologists were included (Agarwala et al., 2015; Jayaswal et al., 2011). Five of the six studies offered some kind of education to participants prior to implementation of the tool (Canale 2018; Jullia et al., 2017; Lee et al., 2019; Wright, 2013), and only two made using the tool during the study period mandatory (Jayaswal et al., 2011; Lee et al., 2019). All six studies reported primarily on process-based outcomes, including adequacy of information transfer, use/adherence/adoption of tool, handoff duration, patient safety-related outcomes, and satisfaction with the handoff tool.

Of these six studies, one study was a randomized controlled trial with level I strength and level A quality of evidence. The validity and accuracy of this study were increased due to an adequate sample size that was met after conducting a power analysis accounting for 90% power, as well as verification of 100% inter-rater agreement amongst data collectors. A 95% confidence interval for means was calculated for checklist scores. A weakness of this study is that the results could have been due to either the tool or the education that was provided (Jullia et al., 2017). Three studies were quasi-experimental studies with level II strength, level C quality evidence (Agarwala et al., 2015; Canale, 2018; Lee et al., 2019). Two used moderate sample sizes (Agarwala et al., 2015; Lee et al., 2019) and one had a small sample size (Canale, 2018), but none indicated if a power analysis was conducted to determine the proper sample size. Additionally, none of the three studies included reports of measures of reliability or validity. Finally, two were nonexperimental studies, level III strength, one with good quality evidence (Wright, 2013), and one with low-quality evidence (Jayaswal et al., 2011). Wright’s (2013) sample size was large, while Jayaswal et al.’s (2011) was moderate, but neither included details of a power analysis for their studies.
**Information Transfer**

Five of the six studies reported on improvement in information transfer when using a standardized process. Agarwala et al. (2015) noted that significant improvements were seen in the frequency of both information relay and recall. Canale (2018) found that significant improvements were seen in both the quality and continuity of information transfer. One of the results of the Jayaswal et al. (2011) study was that 80% of participants felt that the handoff protocol provided a more useful and complete handoff. Jullia et al. (2017) reported that implementation of a handover checklist improved the communication of checklist items by 43%. Finally, in the Lee et al. (2019) study, the proportion of items spontaneously relayed during handoff was 44% higher when using a checklist.

**Adherence to and Adoption of a Standardized Handoff Tool**

Of the four studies that promoted voluntary use of the handoff tool, all four reported on adherence to the checklist. Agarwala et al. (2015) found that voluntary use of a checklist occurred in 60% of handoffs by the end of the study period, which increased to 74% of handoffs eight months after its introduction. Canale (2018) saw an increase in checklist use from only 6% of CRNAs using the checklist six or more times during the two weeks prior to the intervention to 72% using it at least six times in the two weeks following the intervention. Less frequent adherence was seen in the Jullia et al. (2017) study, with only 32% of study respondents indicating that they used the checklist in three out of four cases after training. In the Wright (2013) study, 13.3% of CRNAs did not use the checklist at all, 56.7% of CRNAs used the checklist one to five times, 16.7% used the checklist six to 10 times, 3.3% used the checklist 11 to 15 times, and 10% used the checklist more than 15 times. Ultimately, at the termination of the study, the handoff checklist was made an anesthesia department policy at both Canale’s and
Jayaswal et al.’s institutions, while Agarwala et al. stated that their handoff checklist use was implemented as an internal quality incentive measure (Agarwala et al., 2015; Canale, 2018; Jayaswal et al., 2011).

**Handoff Duration**

Handoff duration, or the amount of time required to perform a handoff, was observed in the Agarwala et al. (2015), Jullia et al. (2019), and Lee et al. (2019) studies. Agarwala et al. (2015) noted that although transfer and retention of information improved, an increase in duration of handoffs was not seen. Similarly, Jullia et al. (2019) reported that improvements in handoffs persisted at the three-month checkpoint without an associated increase in handoff duration. Lee et al. (2019) found that study participants were able to relay more information without increasing the amount of time required for handoffs.

**Patient Safety**

Measures related to patient safety were seen in three of the six prospective studies. Canale (2018) saw significant improvements in providers’ perceptions of patient safety. Jayaswal et al. (2011) reported that 80% of participants felt that the standardized handoff protocol improved patient care. In Wright’s 2013 study, improved patient safety was found to be a trait that participants stated would most likely lead to their willingness to adopt a systematic approach to care transitions.

**Provider Satisfaction**

A final common outcome that was reported in all six studies was user satisfaction. In Agarwala et al.’s 2015 study, clinicians who used the handoff checklist in two-thirds of handoffs reported that they were more satisfied with handoff communication quality ($P = 0.003$). Similarly, although no CRNAs in Canale’s 2018 study reported being strongly satisfied with
their handoff process prior to the intervention, 50% strongly agreed that they were satisfied with handoffs after the intervention. Eighty percent of participants in Jayaswal et al.’s 2011 study thought the handoff tool was more useful than their previous methods, and 62% of participants wanted the handoff tool incorporated into the electronic medical record. In Jullia et al.’s 2017 study, investigators evaluated participants’ satisfaction with both the checklist and the handover training sessions, both of which were found to be a success at 68% and 77% satisfaction rates, respectively. Lee et al. (2018) reported that 90% of participants in their study felt the use of a checklist improved both efficiency and communication during handover while all participants felt that handovers were more thorough when using the checklist. Additionally, all participants responded that they intended to make the checklist part of their daily practice (Lee et al., 2018). Finally, 87% of subjects in Wright’s 2013 study either agreed or strongly agreed that they liked the idea of adopting a standardized handoff process, and all either agreed or strongly agreed that the tool was an effective way to organize information.

Intraoperative handoffs have been linked to a multitude of adverse outcomes, including death. The evidence provided in 13 of these 14 studies helps build a case for incorporating standardized handoffs into practice. Not only have improvements in patient outcomes been identified, but provider satisfaction was also commonly reported with no detrimental impacts on handoff duration.

**Evidence-Based Practice: Verification of Chosen Option**

Utilizing a standardized handoff process has been shown to be an evidence-based practice. Studies have indicated that incorporating the handoff tool into the EHR will further increase usability (Gagnier et al., 2016; Hudson et al., 2015). Thus, this QI project aims to
incorporate a standardized handoff checklist into the EHR and train CRNAs on its access and use.

**Theoretical Framework or Evidence Based Practice Model**

Theoretical frameworks help inform the project, explaining and predicting relationships. For this project, a very helpful theoretical framework was the Shannon and Weaver Model of Communication (see Appendix A). This model was developed to assist with effective communication between senders and receivers while accounting for any external factors, or “noise,” that may affect the communication process. The components of the Shannon and Weaver Model of Communication are the sender, the encoder, the channel, noise, the decoder, and the receiver. In the OR, the sender is the off-going CRNA, and the receiver is the oncoming CRNA. The encoder and decoder are what transmit the message into a signal to send it through a channel, which in this case, would not exist unless the handoff is occurring via telephone. The channel in the OR would be the atmosphere, and the noise would be any of the typical noises and chaos going on around the two individuals participating in the handoff. A clear weakness of this model is that it is linear, not allowing the receiver to participate in active conversation. However, a feedback component was later added by Norbert Weiner, removing the linearity, and allowing the process to be more cyclical (Encyclopedia Britannica, n.d.).

**Methods**

**Project Design**

This project consisted of providing education on the new tool to the participating anesthesia providers, conducting pre-intervention and post-intervention surveys and a post-handoff assessment, and conducting handoff observations for data collection. Prior to the start of the intervention, providers took a pre-intervention survey regarding current handoff procedures.
Handoff observations and post-handoff assessments occurred prior to the intervention stage as well in order to collect data regarding pre-intervention handoff procedures. In the intervention stage, providers were educated on how to use the tool that was being implemented in Epic (see Appendix B). After being educated on how to access and use the handoff tool within the EHR, providers were encouraged to use the tool throughout the intervention period. Handoff observations occurred throughout the intervention, and a post-survey was administered to all participating providers.

**Project Site and Population**

This study was conducted at a tertiary center in the Midwest in the ORs of pods 2, 3, and 5, where surgeries tend to last longer, are higher risk, and involve patients that are more critically ill and have larger numbers of comorbidities, making thorough handovers an essential component of care. Providers in these pods care for adult patients of all races. Only surgeries lasting over two hours in duration were included.

Anesthesia providers studied included only staff CRNAs. Exclusion criteria were surgeries lasting less than two hours and involving anesthesia providers other than CRNAs.

**Stakeholders**

The success of any project depends on gaining buy-in from stakeholders (Dang & Dearholt, 2018). Consulting stakeholders are necessary to provide background information on the topic but do not have decision-making authority. For this project, consulting stakeholders consisted of professional organizations knowledgeable on standardized handoffs, including The Joint Commission, the Multi-Center Handoff Collaborative, American Association of Nurse Anesthetists, and the American Society of Anesthesiologists, along with prior researchers who have published their findings on this topic matter. Some stakeholders were necessary for
approving the project, including the Institutional Review Board, the hospital’s finance department, and various administrators the hospital. A third group of stakeholders followed the project and expected to be informed on how it was progressing, along with any changes made in protocols. These stakeholders included research advisors, hospital administrators, and the Multi-Center Handoff Collaborative. The final stakeholders were those who held the responsibility of completing the project, which included the researcher, the CRNAs involved in the project, research advisors, and administrators who ultimately determined whether or not to implement the change long-term (Johns Hopkins Hospital, 2017). In an indirect sense, patients can also be seen as stakeholders as their needs are important for consideration and their outcomes will ultimately be affected.

Setting Facilitators and Barriers

This project had many strengths and areas for opportunity. At the hospital, evidence-based practice and research are a key focus of advanced practice nurses, and as a teaching institution, evidence-based practice and improvement projects are embraced (Barnes-Jewish Hospital, n.d.). For the organization, this project came with low risk, yet had the potential to benefit staff, patients, and the organization as a whole. For staff, standardizing handoffs can increase both satisfaction and handoff efficiency (Canale, 2018; Galatzan & Carrington, 2018). For patients, standardized handoffs have been shown to increase safety by reducing medical errors, adverse events, and hospital readmissions (Canale, 2018; The Joint Commission, 2017). Over time, these benefits may result in a financial gain for the organization as well as improved staff retention. Another strength of the implementation of this project was that there was already a handoff tool present in Epic. As it is already available, there were minimal costs. Having the support of the Epic team during implementation was an additional added benefit.
Along with strengths came the chance that barriers or limitations to the project could occur. For example, the current anesthesia providers who had not been using a standardized handoff tool may have been opposed to the change. Another possible barrier to implementation is that anesthesia providers may not have used the tool correctly, or may have thought it was too difficult to use or too much work. Providing training on how to use the tool, observing staff, and providing feedback on the use of the tool helped resolve this barrier. Additionally, the ease of use with Epic, a program they are already familiar with, helped to increase buy-in. Similarly, presenting the evidence base behind the project along with the recommendations of professional organizations was helpful in swaying any reluctance.

Past studies have shown that an institutional barrier to implementing evidence-based practice is lack of support and supervision, or more specifically, lack of knowledge, direction, and leadership from administrators. In one study, 91% of nurses indicated that they needed a mentor or champion of projects to enhance the effectiveness of their implementation (Alatawi et al., 2020). Thus, to make the implementation of a standardized handoff tool an even greater success, recruiting members of CRNA leadership to be active in its use and promotion helped to send a clear message of the tool’s importance.

Finally, this specific project did not require a large amount of financial resources outside of the tool (which was already created and available in Epic), and training and education on the use of the tool was done by the author of this paper. Thus, there was not a great deal of pushback from the hospital’s financial department. In fact, hearing of the possible financial benefits of the project and its benefits to both staff and patients were encouraging. Overall, the timing of this project’s implementation seemed perfect.
Resources and Cost-Benefit Analysis

There were several cost considerations for this project (see Appendix C). In terms of personnel, the involved CRNAs had to be educated on how to use the handoff tool. Although the majority of this education occurred through e-mail correspondence and posted flyers, additional in-person teaching was occasionally necessary. Thus, the cost of educating 50 providers for one hour each was accounted for. Fifty was chosen as the goal was to collect data on 50 handoff observations. Next, the cost of materials and supplies was considered. For this project, this was mainly the paper and ink or printing costs for flyers, surveys, and assessment tools. Finally, the cost of the data analysis software, SPSS Statistics, was included. Other non-monetary costs included the researcher’s personal time invested in completing the project, as well as the time of the CRNAs who were expected to read the communications regarding the tool and use it. However, these costs were minimal compared to the benefits that will be incurred by both patients and the institution over time through increased patient safety, as well as for providers if their satisfaction is improved.

Ethical Considerations/Protection of Human Subjects

Washington University IRB approval to implement a quality improvement project was obtained prior to initiating the DNP Project. All participants were protected by the Health Insurance Portability and Accountability Act of 1996, which protects the privacy of patients’ health information (Office for Civil Rights, 2013). All research personnel, students, and staff on the study team followed the general OR standards of care. Data collected did not include patient identifiers, and all data were stored on a password-protected computer.

The risks to patients participating in this project were no different than the risks of receiving standard hospital surgical care. As the study only involved the handoff process, when
patient demographics were used for study purposes, they were coded with identification numbers instead of patient identifiers. All anesthesia provider identifiers were also excluded.

Cultural considerations for this project were minimal but required ensuring that patients did not have any specific requirements for the gender, amount, or other characteristics of individuals present in the operating room during surgery as observers needed to be present at certain times to observe handoffs.

**Recruitment Strategies**

Flyers detailing the project were hung in anesthesia provider common spaces, including the second and third floor anesthesia lounges. On nights prior to observation dates, CRNAs who were scheduled to work the following day were e-mailed the consent information sheet and a handout about the project. On observation days, the scheduling coordinator relayed information regarding what rooms were undergoing shift changes, and the CRNAs who were staffing those rooms were again provided with a project information sheet and a consent sheet, and they were asked if they were willing to participate. They were informed that their participation was completely voluntary, and if they did not wish to participate, their handoff was not observed.

**Measurement Instruments**

The dependent variables in this project included staff perceptions of handoff communications, staff satisfaction, completeness of handoffs, and duration of handoffs both pre-intervention and post-intervention. In order to measure these dependent variables, the following instruments were used: a pre-intervention survey to assess current handoff communication methods, including satisfaction with and efficacy of these methods, an intraoperative handoff observation assessment tool that was used to track which items were covered during handoffs, a
post-handoff assessment that was developed to record satisfaction with the handoff process and retention of specific patient information, a post-intervention survey that was compared to the pre-intervention survey, and a stopwatch to measure the duration of handoffs. The number of times the tool has been used was tracked in Epic to measure adherence to the intervention; this was done automatically when the “Handoff Complete” button in the EHR was clicked.

A simple pre-intervention survey was developed to assess current handoff practices (see Appendix D). This survey was adapted from Canale’s (2018) pre-survey, but does not have measures of reliability or validity. It consisted of five multiple-choice questions and two open-ended questions to provide additional insight and help guide improvements of the tool.

The intraoperative handoff observation assessment tool was created by Agarwala et al. (2015). An adapted version of this tool was used during handoff observations to evaluate items being relayed in handoffs (see Appendix E). The same tool was used during handoff observations in both the pre-intervention and post-intervention stages. Items covered in each stage were evaluated. Demographic patient variables such as age, gender, weight/body mass index, procedure type, major pre-existing medical problems, and American Society of Anesthesiologists physical status classification score (ASA score) were included. Additionally, the type of provider giving and type of provider receiving the handoff communication were noted. The adapted post-handoff assessment was administered immediately following the handoff observations in both the pre-intervention and post-intervention stages (see Appendix F). The purpose of this assessment was to determine satisfaction with the handoff and retention of specific patient information at the time of handoff. Although the original tool has been used previously, its reliability and validity are not established.
In the post-intervention stage, a final survey was administered to staff that used the standardized handoff tool to determine overall satisfaction with the handoff tool including usability, as well as plans for adherence (see Appendix G). This survey was a 10-item survey consisting of eight multiple-choice and two open-ended questions. Items adapted from Canale’s (2018) post-intervention survey were included for comparison to the pre-intervention survey, but the survey also included additional questions regarding usability, adapted from the System Usability Scale (SUS). The SUS was first used in 1986, can be used with small sample sizes, and is both reliable and valid (Sauro, 2011). Specifically, after a comprehensive evaluation of the tool was completed, the SUS was found to have a Cronbach’s Alpha score of 0.92, with the highest possible score being 1.0 (Orn, 2017). Permission was not necessary to use any of the included instruments.

**Data Collection Procedures**

For this project, the Plan, Do, Study, Act framework was used. The project was implemented in stages, including pre-intervention, intervention, and post-intervention. The author was present in the OR when scheduling permitted and observed handoffs in rooms where the providers were changing shift. Only permanent handoff communications were observed.

In the pre-intervention stage, the pre-survey was administered to CRNAs to assess perceptions of and satisfaction with current handoff procedures. This also included going into the ORs during handoffs and observing handoffs using current handoff methods. The Observational Assessment Tool and Post-Handoff Assessments were used to gather data on the dependent variables of staff perceptions of handoff communications, completeness of handoffs, and staff satisfaction with handoffs using current methods. Patient demographics including age, gender, weight/body mass index, procedure type, major pre-existing medical problems, and ASA score
were noted, along with the type of provider giving handoff and the type of provider receiving the handoff. This was necessary in order to compare groups from the pre-intervention and post-intervention stages, and patient demographics were verified through the EHR. Handoffs were timed using a standard stopwatch.

After the pre-intervention stage was complete, CRNAs were informed of the new handoff tool in Epic and how to use it for handoff communications, along with evidence-based research regarding the use of standardized handoffs. E-mails were sent with screenshots of the tool and how to access it, flyers with information about the tool were posted in the anesthesia lounges, and when necessary, instructions on the use of the tool were provided prior to handoffs during handoff observations in the intervention stage.

During the intervention stage, the actual use of the handoff tool in Epic began. Each time the tool was used, the “Handoff Complete” button was clicked, which tracked use of the tool in the EHR. Handoff observations occurred again, this time assessing handoffs using the new tool. Data transfer, staff perceptions of the handoff, and staff satisfaction were tracked using the Observational Assessment Tool and the Post-Handoff Assessment. Handoffs were again timed using a standard stopwatch. After handoffs using the new tool, the Post-Intervention Survey was administered. This survey was similar to the Pre-Intervention Survey which allowed for comparison. This survey once again assessed provider satisfaction with the handoff, perceptions of the handoff, and usability of the handoff tool.

Data Analysis

The “Study” stage occurred post-intervention. In the study stage, data were analyzed to determine if there were significant differences between the pre-intervention and post-intervention data. Descriptive statistics were used. Data analysis was done using SPSS Statistics software and
Microsoft Excel, along with the assistance of a statistician. The goal of data analysis was to determine if using the new tool resulted in improvements in the previously mentioned dependent variables. A two-sample t-test was used to compare pre-intervention and post-intervention patient demographics to ensure that the groups were similar, ruling out differences between groups as a potential confounder. A two-sample t-test was also used to compare handoff duration and total number of items relayed in pre-intervention and post-intervention handoffs. P values < 0.05 were considered statistically significant. A chi-square test and Fisher’s exact test were used to determine if there was an association between post-handoff assessment results and utilization of a standardized handoff process. For the chi-square test, P values < 0.0001 were considered significant. For the Fisher’s exact test, P < 0.05 was considered statistically significant. A chi-square test was used to compare pre-intervention and post-intervention survey results and recall Post-Handoff Assessment Tool. P values < 0.0001 were considered statistically significant. Data is displayed in tables comparing pre-intervention and post-intervention results. The results were used to determine if the tool should be adopted or further revised. This comprised the “Act” stage of the study.

It was not anticipated that outcomes would be influenced by any cultural issues. All team members at the hospital spoke English, which is the language that the materials were provided in. The handoff tool was also in English. If patients had cultural considerations that would prevent the observation from occurring, then that observation did not occur.

**Evaluation and Outcomes**

**Results**

A total of 37 handoff observations occurred across three pods at a large academic medical center. Fifteen handoffs occurred in the six-week pre-intervention stage and 22 occurred in the
eight-week post-intervention stage. One of the 15 pre-intervention observations was excluded as the CRNA giving the handoff was already aware of and using the handoff tool, which would have skewed results. Patient demographics including age, body mass index (BMI), total number of comorbidities, and ASA score were compared between stages to ensure that groups were similar. The average age of patients in the pre-intervention stage was 57.2 years with a range of 21.0-75.0, and in the post-intervention stages was 59.0 with a range of 27.0-87.0. The average BMI of patients in the pre-intervention stage was 28.8 with a range of 16.2-41.4, and in the post-intervention stage was 29.7 with a range of 20.4-53.1. The average number of comorbidities present in the pre-intervention stage was 5.3 with a range of 0.0-14.0, and in the post-intervention stages was 6.3 with a range of 0.0-16.0. The average ASA score in the pre-intervention stage was 3.1 with a range of 2.0-5.0, and in the post-intervention stage was 3.0 with a range of 1.0-5.0. When comparing patient demographics between the pre-intervention and post-intervention groups, P > 0.05 was calculated for all demographic variables. Thus, there were no significant differences between pre-intervention and post-intervention conditions that could have confounded the results (see Table 1 and Appendix H).

**Handoff Duration**

Handoffs were timed using a standard stopwatch. In the pre-intervention stage, the average handoff time was 290.3 seconds with a range of 100.0-957.0 seconds. In the post-intervention stage, the average handoff time was 273.0 seconds with a range of 65.0-623.0 seconds. Implementing a standardized handoff tool did not have an effect on handoff duration (P = 0.7932; see Appendix I).

**Information Transfer**

Information transfer was assessed using the Observational Assessment Tool. In the pre-
intervention stage, an average of 15.6 of the 22 items were relayed during handoffs with a range of 12.0-20.0. In the post-intervention stage, an average of 17.13 of the 22 items were relayed during handoffs with a range of 10.0-21.0. No significant difference was found in content shared during handoffs. However, more content was shared in the post-intervention stage, as is seen in the mean difference between groups (see Appendix J). The handoff items that showed the greatest improvement in relay included anesthetics used (57.8% increase in the post-intervention stage), pre-operative medications administered (25.9% increase in the post-intervention stage), and patient allergies (25.3% increase in the post-intervention stage). Increases in information relay were seen with 13 out of the 22 included items (see Appendix K).

Information retention was assessed using the Post-Handoff Assessment in both the pre-intervention and post-intervention stages. Questions were asked regarding fluids administered, muscle relaxants used, antibiotics used, and time of next antibiotic dose. For all questions, no association was found between information recall of fluids, muscle relaxant, antibiotic administered, time of next antibiotic dose, and whether or not a standardized handoff method was used ($\chi^2 P > 0.0001$, Fisher’s Exact Test $p > 0.05$; see Appendix L).

**Satisfaction with Handoffs**

Staff satisfaction with handoffs was measured in two different ways. First, staff satisfaction with the general handoff format was assessed using the Pre-Intervention Survey and Post-Intervention Survey and results were compared between stages. Additionally, satisfaction with each individual handoff was assessed using the Post-Handoff Assessment. These results were also compared between the pre-intervention and post-intervention stage.

On the Pre-Intervention Survey and Post-Intervention Survey, the first two questions compared were in regards to satisfaction with the handoff process when giving/receiving report
of an anesthetized patient and the handoff process in question being an appropriate and effective way of transferring important patient information. For these questions, no associations were found between satisfaction with or appropriateness/effectiveness of handoff and handoff type (P = 0.0740 and P = 0.0652). The third question compared was, “This handoff process lends itself to mistakes (pre: no standardized handoff, post: standardized handoff).” For this question, more providers agreed that the non-standardized handoff process lends itself to mistakes more than the standardized process, and a significant difference was found (P < 0.0001; see Appendix M).

Using the Post-Handoff Assessment, staff satisfaction with information conveyed in individual handoffs was assessed in both the pre-intervention and post-intervention stages. Questions were asked regarding whether the information was communicated in a clear, logical, and concise manner, whether or not future intraoperative and postoperative concerns were discussed, and if the recipient felt the handoff was rushed. No association was seen between satisfaction with information communicated and handoff type (P = 0.1427, 0.6707, and 0.2594, respectively; see Appendix N).

**Adherence to Tool Use**

Adherence to tool use was monitored by checking the total amount of times that CRNAs clicked the “Mark Handoff Complete” button in Epic during a permanent transition. Overall, an increase in tool use was seen in the post-intervention stage in all three pods that the intervention occurred in. In pod 2, handoff tool use went from 0.90% in the pre-intervention stage to 3.27% in the post-intervention stage. In pod 3, handoff use went from 0.68% in the pre-intervention stage to 0.86% in the post-intervention stage. In pod 5, handoff use went from 1.45% in the pre-intervention stage to 2.52% in the post-intervention stage (see Appendix O). Of note, tool use was assessed over all cases with no exclusion criteria, meaning that cases shorter than two hours
that may not have even had a permanent handoff transition take place were included, which could contribute to these low numbers.

**Analysis of Open-Ended Questions**

Two open-ended questions were asked at the end of the Pre-Intervention Survey along with two open-ended questions at the end of the Post-Intervention Survey. Questions were analyzed and grouped based on themes.

The first question from the Pre-Intervention Survey asked respondents to list positive aspects of the current, non-standardized handoff process. Twenty participants responded. Ten of the 20 responses were focused on the ability to tailor non-standardized handoffs to make them more patient-specific and based on what the person giving handoff deems is important. Two of the responses mentioned that the standard handoff method was quick. Three responses discussed the ease of the standard handoff method and that it is what they were familiar with. Four responses were based on completeness of non-standardized handoffs, and the final response just mentioned that the participant likes that handoffs occur at the bedside, which is not specific to any type of handoff.

The second question on the Pre-Intervention Survey asked participants to list any suggestions they might have for improvements to the non-standardized handoff process. Eighteen participants responded. Of the 18 responses, 15 reported they would like to have a more standardized protocol or structured handoff process; one individual specified that they thought standardizing handoffs would lead to fewer mistakes and omissions of pertinent information. Of the other three responses, one individual wanted a medication list available at the end of a case, one commented on how personality traits can get in the way of handoffs, and a final person simply remarked that they had no suggestions for improvement.
On the Post-Intervention Survey, the first question asked participants to list positive aspects of the standardized handoff process. Twenty-eight participants responded. Twenty-one out of 28 responses mentioned that the standardized handoff process was thorough and that having all of the information in one place made it less likely for the individual giving a handoff to leave out important patient details. Three participants remarked on the organization of the standardized handoff procedure. Two individuals commented that they would like it if the tool became a routine procedure. One person stated that the standardized handoff process ensures a safe transfer of care, and the final person simply responded “Everything.”

The second question on the Post-Intervention Survey asked respondents to list any suggestions they might have for improvement to the standardized handoff process. Twenty participants responded. Of these 20 responses, nine commented that the vitals flowsheet/intraoperative case record should be removed from the middle of the handoff tool as it takes up too much space and is burdensome to scroll through. Three participants responded that the tool includes too much information/should be decluttered, which could also be in reference to the intraoperative case record portion of the tool. Three individuals made suggestions for additional information that should be included in the tool, specifically pertinent lab values and echocardiogram results. Three individuals responded that they had no suggestions for improvement or were unsure of what improvements could be made. One person thought the icon to access the handoff tool should be more easily accessible, and the last person stated that everyone should use the tool.
Discussion of Findings/Outcomes

Handoff Duration

With the introduction of a standardized handoff tool, providers may be concerned that it will increase the duration of handoffs. However, previous studies have proven this to not be the case, with standardized handoffs leading to increased information transfer with no impact on duration (Agarwala et al., 2015; Jullia et al., 2019; Lee et al., 2019). The results of this study confirmed this finding with no significant differences found in handoff duration between pre-intervention and post-intervention groups.

Information Transfer and Retention

Though no significant differences were found in information transfer, the mean number of items relayed in the post-intervention stage was greater than in the pre-intervention stage (17.14 vs. 15.6, respectively) with improvements seen in 13 out of 22 items. This improved information transfer implies handoff communications were improved, which could lead to decreased errors in handoff communications, and decreased patient harm. In the future, with continued improvement to the tool, these numbers could likely increase even more.

No significant differences were found in information retention regarding fluids administered, muscle relaxants given, and antibiotics administered during pre-intervention and post-intervention stages. However, it should be noted that while almost all providers knew what antibiotic was administered in the pre-intervention and post-intervention stages (86.7% and 95.5%, respectively), almost half of providers in the pre-intervention stage (46.7%) were unaware of when the next dose was due, vs. only 18.2% in the post-intervention stage (P = 0.0627). This finding can significantly impact postoperative infection rates. As of 2021, surgical site infections were still a leading cause of healthcare-related infections and hospital
readmissions, and reduction of preventable surgical site infections remains a healthcare priority (Bardia et al., 2021). Improving communication on this metric would be an easy initial step to take in remedying this problem.

**Satisfaction with Handoffs**

No significant differences were found in questions regarding staff satisfaction with pre-intervention vs. post-intervention conditions. However, a larger portion of participants strongly agreed that they were satisfied with the handoff process when a standardized tool was used (36.4%) compared to when no standardized tool was used (20.0%). Additionally, one participant disagreed when asked if they were satisfied with the handoff process in the pre-intervention stage, compared to zero participants in the post-intervention stage. When asked if participants felt the different methods of handoff processes were appropriate and effective ways of transferring important patient information, 47.6% agreed that utilizing a standardized handoff tool was appropriate and effective, vs. only 20.0% when not using a standardized handoff tool. A significant difference was found in regards to the likelihood of each handoff process to lend itself to mistakes. In the pre-intervention stage, 56.7% of participants agreed or strongly agreed that not using a standardized handoff tool lends itself to mistakes, while only 20.5% of participants agreed or strongly agreed that the standardized handoff tool lends itself to mistakes ($P < 0.0001$).

No significant differences were found in satisfaction rates with the quality of individual handoffs in the pre-intervention and post-intervention stages. Participants in both stages of the study responded that they were relatively satisfied with how clearly, logically, and concise handoffs were ($P = 0.1427$). Additionally, similar results were seen when asked if future intraoperative and postoperative concerns were discussed ($P = 0.6707$). Participants also did not feel as if handoffs were rushed when utilizing either handoff method ($P = 0.2594$).
**Adherence to Tool Use**

Adherence to tool use increased in all pods in the post-intervention stage. However, due to the analysis included all cases that occurred during each stage of the project, it is difficult to tell how much the increase actually was.

**Analysis of Open-Ended Questions**

After analyzing the open-ended questions, it seems that participants do like the idea of a standardized handoff tool as it is thorough and provides all of the pertinent patient information in one place. However, users may benefit from the suggested changes. Seeing as 12 individuals mentioned that the current tool needs decluttered and/or that they do not like the vitals flowsheet/intraoperative case record, removing this portion of the tool would likely increase tool use and provider satisfaction with the tool. Once this space is freed up, the most pertinent lab values and echocardiogram results could be incorporated without taking away from the simplicity of the tool.

**Strengths and Limitations of Findings**

A strength of this study was that all surveys and assessments were completed at the time of handoff observations, which eliminated bias due to non-response. However, there were still a few instances of questions being left unanswered due to the preference of the participant. A second strength of this study was that a statistician who had no ties to the project was employed for data analysis to help eliminate analysis bias. A third strength of this project was that all handoff observations were completed by a single researcher, which eliminated instruction bias, which often varies from person to person.

A limitation of this study was that it took place in a single hospital with a small sample size and all participants were CRNAs, which may make the results less generalizable to a larger
population. Another limitation of the study was that a single researcher conducted all handoff observations, which could lead to observer bias. However, a standardized set of data collection tools were used that did not allow for subjective interpretation to help eliminate this bias. A third limitation of the study was that all participants were aware that their handoffs were being observed, which could result in the Hawthorne effect. To combat this, no participants were told ahead of time what items the observer was assessing for, and all participants were encouraged to perform handoffs as they normally would. A fourth limitation of this study was that the author did not evaluate utilization of the tool’s impact on patient outcomes. A final limitation of the study is that the observational time frame was limited, which resulted in a smaller number of handoff observations occurring than was originally intended.

**Evaluation of the Process**

Obtaining adequate handoff numbers proved to be more difficult than initially anticipated. Although only one CRNA refused a handoff observation during the study period, there were other barriers that were encountered. For example, most handoff observations occurred on Tuesdays. Because of this, it was often the same CRNAs working and the same 10- and 12-hour shift CRNAs providing shift relief, so it was difficult to get a large amount of unique CRNA participants. Another unforeseen barrier to this project was that in the pre-intervention stage, on many occasions the eight-hour shift workers were not relieved by five o’clock, which was the time the schedule coordinator was off work and thus the time the researcher stopped data collection. This limited the number of handoffs that could be observed. A third barrier was that this project was only approved for pods 2, 3 and 5, which excluded handoff observations that could have been completed in pods 1 and 4. Finally, only permanent
handoffs between CRNAs were observed. If temporary break transitions and handoffs involving residents were included, a greater number of handoff observations would have been acquired.

**System and Practice Impact**

**Implications for Organizational and Systems Change**

Although many statistically significant differences were not seen between pre-intervention and post-intervention conditions, positive outcomes were noted. Going forward, there is room for improvement of the current tool, which can be guided by responses to the open-ended questions from the pre-intervention and post-intervention surveys. Future studies should include all anesthesia providers and all handoffs being done by anesthesia providers, including temporary break handoffs. Additionally, improved analysis on tool use needs implemented so that statistics on tool use can be tailored to only those cases that required a handoff transition. With time and continued studies on the efficacy of the tool, it has the potential to lead to system-wide improvements in handoff communications, paving the way for other expected positive outcomes.

**Recommendations for Nursing Practice**

Future studies including improvements to the current standardized tool based on the survey responses, specifically the addition of pertinent details that were noted to be lacking and the removal of elements that were seen as burdensome, are recommended over a longer study period. Additional education on the use of and how to access the tool may be necessary. Re-locating the tool within Epic could improve usability.

**Sustainability**

The handoff tool has already been incorporated into the EHR for long-term use. However, results obtained from this study indicate that further improvements need to occur in
order to ensure that the tool is operating at maximal efficiency. Additionally, ongoing education on the use of the tool should occur, and all new-hire anesthesia providers should be oriented to the tool before administering anesthesia to their patients and giving patient handoffs.

**Summary and Conclusion**

**Project Summary**

Significant adverse events and even death may occur as a result of inadequate intraoperative handoffs. Anesthesia providers at the hospital have access to a simple, low-cost, evidence-based intervention that can help curb the occurrence of these events, thus avoiding patient harm while also reaping the benefits of increased provider satisfaction and potentially decreased costs. Although there were some barriers to the project’s implementation, there were also many facilitators. An initial set of positive outcomes were seen, which have the potential to increase with continued improvements of the handoff tool. Adequate education on the necessity of a standardized handoff tool coupled with the ease of accessing the tool through the EHR will most likely lead to the tool’s adoption and success over time.

**Plan for Dissemination**

The process and results of this project will be shared in a public presentation. The results will be presented in a poster presentation at a Nursing Research Day. Finally, they will be submitted for publication in the International Student Journal of Nurse Anesthesia.

**Acknowledgements**

A special thank you to my team members, Dr. Abraham and Dr. Henrichs, who were with me at all stages of this project for feedback and suggestions. Additionally, thank you to the other individuals who helped out along the way, including Dr. Ling Chen who assisted with data analysis, and Derek Hartford who helped with data extraction regarding tool use in Epic.
A final thanks to the scheduling coordinator, Jen Mahan, who worked with me on every observation day to ensure that I was able to acquire as many handoff observations as possible.
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### Table 1

**Patient Demographics**

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Appendix A

Shannon-Weaver’s Model of Communication

SHANNON-WEAVER’S MODEL OF COMMUNICATION

(Shannon and Weaver Model of Communication, n.d.)
Appendix B

How to Access Epic Intraoperative Handoff Tool

How to Access and Use the Intraoperative Handoff Tool in Epic

Step 1: Open the intraprocedure flowsheet.

Step 2: On the right intraop sidebar, click the arrow to the right of “More” to access the dropdown menu.

Step 3: From the dropdown menu, choose “Anesthesia Handoff.”

Step 4: When handoff is complete, hit the button located at the very bottom of the Anesthesia Handoff sidebar that says “Mark handoff complete.”
### Appendix C

#### Budget Table

<table>
<thead>
<tr>
<th>Nature of Expenditure/Item</th>
<th>Cost per Unit</th>
<th># Units</th>
<th>Total Estimated Cost</th>
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<tbody>
<tr>
<td><strong>Direct Costs</strong></td>
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<td>Personnel</td>
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<td></td>
<td></td>
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<tr>
<td>CRNA Time</td>
<td>$90.96</td>
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<tr>
<td><strong>Materials and Supplies</strong></td>
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<tr>
<td>Handoff Tool</td>
<td>$0.60</td>
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<td>$12.00</td>
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<td>Informative Flyers</td>
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<tr>
<td>Observational Assessment Tools</td>
<td>$0.14</td>
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<tr>
<td>Post-Handoff Assessments</td>
<td>$0.14</td>
<td>50</td>
<td>$7.00</td>
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<tr>
<td>Pre-Intervention Surveys</td>
<td>$0.14</td>
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</tr>
<tr>
<td>Post-Intervention Surveys</td>
<td>$0.14</td>
<td>50</td>
<td>$7.00</td>
</tr>
<tr>
<td><strong>Technology</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardware/Software</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IBM SPSS Statistics</td>
<td>$113.00</td>
<td></td>
<td>$113.00</td>
</tr>
</tbody>
</table>

**TOTAL**                    |               |         | $4,701.00            |
Appendix D

Pre-Intervention Survey

1) Do you currently use a standardized handoff process when either giving or receiving handoff report of an anesthetized patient? If yes, please explain.
   Yes                    No

2) I am satisfied with the current transfer of care process when giving/receiving report of an anesthetized patient.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree

3) The current handoff process is an appropriate and effective way of transferring important patient information.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree

4) The current handoff process lends itself to mistakes.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree

5) I feel very confident giving handoff using the current handoff process.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree

6) Positive aspects of the current handoff process:
   _______________________________________________________

7) Suggestions for improvements to the current handoff process:
   _______________________________________________________

Appendix E

Observational Assessment Tool

Date: [ ] / [ ] / [ ]  Room #: [ ]

Handoff times:  Start: [ ]  Finish: [ ]

Handoff Providers:
Giver:  [ ] Resident/Fellow  [ ] CRNA  [ ] Attending
Receiver: [ ] Resident/Fellow  [ ] CRNA  [ ] Attending

General Information (Sp=spontaneously relayed; R=conveyed upon request; N/A= non-applicable (for example: view in MAC, LMA or trached pt.))

Sp  R
[ ] [ ] Age
[ ] [ ] Gender
[ ] [ ] Weight
[ ] [ ] Procedure
[ ] [ ] Major pre-existing medical problems/PMH (includes: “no significant PMH”)
[ ] [ ] Preoperative medications (check also if “no meds” mentioned)
[ ] [ ] Allergies (check also if “no allergies” mentioned)

Induction
Sp  R  N/A
[ ] [ ] Induction Agents (versed, fentanyl, propofol, muscle relaxants (cisatracurium, vecuronium, rocuronium))

Airway management
[ ] [ ] Easy/difficult
[ ] [ ] Blade/View/ETT size

Intraoperative course
Maintenance of anesthesia
[ ] [ ] Anesthetics (isoflurane, sevoflurane, propofol, remifentanil)
[ ] [ ] Muscle relaxants (cisatracurium, vecuronium, rocuronium)
[ ] [ ] Pain relievers (fentanyl, dilaudid, morphine, toradol)
[ ] [ ] Pressors
[ ] [ ] Antiemetics (zofran, halodol, scopolamine patch, decadron)

[ ] [ ] Lines
[ ] [ ] Estimated Blood Loss
[ ] [ ] Urine Output (if Foley catheter is in place)
[ ] [ ] Fluids/Blood administered

[ ] [ ] Operative Course (problems, or absence thereof)
[ ] [ ] Antibiotics, other meds pending administration (e.g., heparin)
[ ] [ ] [ ] Potential areas of concern

[ ] [ ] Postoperative Plan (includes discussion of regional anesth if present)
[ ] [ ] Introduction of relieving anesthesia care provider to OR team

(Agarwala et al., 2015)
Appendix F

Post-Handoff Assessment

1) Satisfaction with information conveyed

A) Was the information communicated in a clear, logical, and concise manner?
   [ ] Very Satisfied (Outstanding)
   [ ] Somewhat Satisfied (Good)
   [ ] Neutral (Acceptable)
   [ ] Somewhat Unsatisfied (Needs some improvement)
   [ ] Very Unsatisfied (Unacceptable)

B) Were future intra-operative and post-operative concerns discussed?
   [ ] Very Satisfied (Outstanding)
   [ ] Somewhat Satisfied (Good)
   [ ] Neutral (Acceptable)
   [ ] Somewhat Unsatisfied (Needs some improvement)
   [ ] Very Unsatisfied (Unacceptable)

C) Did you feel that the handoff was rushed?
   [ ] Not at all (Outstanding)
   [ ] A little rushed (Good)
   [ ] Neutral (Acceptable)
   [ ] Somewhat rushed (Needs some improvement)
   [ ] Very Rushed (Unacceptable)

2) Information transfer and retention

A) How much fluids have been given?  
   Approximate amount: [ ]  
   Does not know: [ ]

B) What muscle relaxant was used?  
   N/A: [ ]  
   Knows information: [ ]  
   Approximate amount: [ ]  
   Does not know: [ ]

C) What antibiotic was used?  
   N/A: [ ]  
   Knows information: [ ]  
   Approximate amount: [ ]  
   Does not know: [ ]

   When is the next dose due?  
   N/A: [ ]  
   Knows information: [ ]  
   Does not know: [ ]

(Agarwala et al., 2015)
Appendix G

Post-Intervention Survey

1) How many times have you used the standardized handoff tool when giving or receiving report of an anesthetized patient?
   a. 0
   b. 1-5
   c. 6-10
   d. > 10

2) I am satisfied with standardized handoff process when giving/receiving report of an anesthetized patient.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree

3) The standardized handoff process is an appropriate and effective way of transferring important patient information.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree

4) The standardized handoff process lends itself to mistakes.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree

5) I think that I would like to use the standardized handoff process frequently.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree

6) I thought the standardized handoff process was easy to use.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree
7) I would imagine that most people would learn to use the standardized handoff process very quickly.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree

8) I felt very confident giving report using the standardized handoff process.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree

9) Positive aspects of the standardized handoff process:

________________________________________________________________________

10) Suggestions for improvements to the standardized handoff process:

________________________________________________________________________
## Appendix H

### Two-Sample T-test for Comparison Between Pre and Post Groups

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<thead>
<tr>
<th>Demographic</th>
<th>p Value</th>
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<tbody>
<tr>
<td>Age</td>
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<tr>
<td>BMI</td>
<td>0.73</td>
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<tr>
<td># of Comorbidities</td>
<td>0.51</td>
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<tr>
<td>ASA Score</td>
<td>0.78</td>
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</tbody>
</table>
# Appendix I

## Handoff Duration in Seconds

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Range</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-intervention</td>
<td>290.3</td>
<td>216.0</td>
<td>100.0-957.0</td>
<td>0.7932</td>
</tr>
<tr>
<td>Post-intervention</td>
<td>273.0</td>
<td>212.5</td>
<td>65.0-623.0</td>
<td></td>
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</tbody>
</table>
Appendix J

Items Relayed During Handoff Observations (Out of 22)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Range</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>15.6</td>
<td>15.0</td>
<td>12.0-20.0</td>
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<tr>
<td>Post</td>
<td>17.14</td>
<td>17.5</td>
<td>10.0-21.0</td>
<td></td>
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Appendix K

Frequency of Information Relayed from Outgoing to Incoming CNRA

<table>
<thead>
<tr>
<th>Item</th>
<th>Without Handoff Tool, % (n out of 14)</th>
<th>With Handoff Tool, % (n out of 22)</th>
<th>Was an improvement seen?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>92.9 (13)</td>
<td>100 (22)</td>
<td>Yes</td>
</tr>
<tr>
<td>Gender</td>
<td>100 (14)</td>
<td>100 (22)</td>
<td>No change</td>
</tr>
<tr>
<td>Weight</td>
<td>28.6 (4)</td>
<td>18.2 (4)</td>
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</tr>
<tr>
<td>Procedure</td>
<td>85.7 (12)</td>
<td>100 (22)</td>
<td>Yes</td>
</tr>
<tr>
<td>Past Medical History</td>
<td>92.9 (13)</td>
<td>100 (22)</td>
<td>Yes</td>
</tr>
<tr>
<td>Pre-op Meds Given</td>
<td>28.6 (4)</td>
<td>54.5 (12)</td>
<td>Yes</td>
</tr>
<tr>
<td>Allergies</td>
<td>42.9 (6)</td>
<td>68.2 (15)</td>
<td>Yes</td>
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<tr>
<td>Induction Agents</td>
<td>64.3 (9)</td>
<td>77.3 (17)</td>
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</tr>
<tr>
<td>Easy/Difficult Intubation</td>
<td>100 (14)</td>
<td>90.9 (20)</td>
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</tr>
<tr>
<td>Blade/View/ETT</td>
<td>85.7 (12)</td>
<td>90.9 (20)</td>
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<td>Anesthetics</td>
<td>28.6 (4)</td>
<td>86.4 (19)</td>
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<tr>
<td>Muscle Relaxants</td>
<td>92.9 (13)</td>
<td>90.9 (20)</td>
<td>No</td>
</tr>
<tr>
<td>Analgesics</td>
<td>100 (14)</td>
<td>95.5 (21)</td>
<td>No</td>
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<tr>
<td>Pressors</td>
<td>78.6 (11)</td>
<td>72.7 (16)</td>
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<tr>
<td>Antiemetics</td>
<td>35.7 (5)</td>
<td>36.4 (8)</td>
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<tr>
<td>Lines</td>
<td>100 (14)</td>
<td>95.5 (21)</td>
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<tr>
<td>Estimated Blood Loss</td>
<td>35.7 (5)</td>
<td>54.5 (12)</td>
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</tr>
<tr>
<td>Urine Output</td>
<td>57.1 (8)</td>
<td>68.2 (15)</td>
<td>Yes</td>
</tr>
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<td>Fluids/Blood Administered</td>
<td>85.7 (12)</td>
<td>50 (11)</td>
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<tr>
<td>Operative Course</td>
<td>64.3 (9)</td>
<td>81.8 (18)</td>
<td>Yes</td>
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<td>Antibiotics</td>
<td>85.7 (12)</td>
<td>95.5 (21)</td>
<td>Yes</td>
</tr>
<tr>
<td>Potential Areas of Concern</td>
<td>64.3 (9)</td>
<td>81.8 (18)</td>
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</table>
### Appendix L

#### Information Retention

<table>
<thead>
<tr>
<th>Question</th>
<th>N: Pre-Intervention</th>
<th>N: Post-Intervention</th>
<th>$\chi^2$</th>
<th>Fisher’s Exact Test</th>
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<tbody>
<tr>
<td>How much fluids have been given?</td>
<td></td>
<td></td>
<td>0.4025</td>
<td>0.5946</td>
</tr>
<tr>
<td>Knows information</td>
<td>15</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does not know information</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What muscle relaxant was used?</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knows information</td>
<td>15</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does not know information</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What antibiotic was used?</td>
<td></td>
<td></td>
<td>0.3363</td>
<td>0.2973</td>
</tr>
<tr>
<td>Knows information</td>
<td>13</td>
<td>21</td>
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<td></td>
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<tr>
<td>Does not know information</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When is the next dose due?</td>
<td></td>
<td></td>
<td>0.0627</td>
<td>0.0551</td>
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<tr>
<td>Knows information</td>
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<td>18</td>
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</tr>
<tr>
<td>Does not know information</td>
<td>7</td>
<td>4</td>
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Appendix M

Staff Satisfaction: Pre-Intervention and Post-Intervention Survey Results

<table>
<thead>
<tr>
<th>Question</th>
<th>N: Pre-Intervention</th>
<th>N: Post-Intervention</th>
<th>Chi-Square Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am satisfied with this handoff process.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly agree</td>
<td>6</td>
<td>16</td>
<td>0.0740</td>
</tr>
<tr>
<td>Agree</td>
<td>19</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>This handoff process is an appropriate and effective way of transferring important patient information.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly agree</td>
<td>6</td>
<td>20</td>
<td>0.0652</td>
</tr>
<tr>
<td>Agree</td>
<td>19</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>This handoff process lends itself to mistakes.</td>
<td></td>
<td></td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>0</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>17</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td>9</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>4</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>0</td>
<td>0</td>
<td></td>
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</table>
Appendix N

Staff Satisfaction: Post-Handoff Assessment Results

<table>
<thead>
<tr>
<th>Question</th>
<th>N: Pre-Intervention</th>
<th>N: Post-Intervention</th>
<th>Chi-Square Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Was the information communicated in a clear, logical, and concise manner?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very satisfied</td>
<td>10</td>
<td>19</td>
<td>0.1427</td>
</tr>
<tr>
<td>Somewhat satisfied</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Somewhat unsatisfied</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Very unsatisfied</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Were future intraoperative and postoperative concerns discussed?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very satisfied</td>
<td>11</td>
<td>17</td>
<td>0.6707</td>
</tr>
<tr>
<td>Somewhat satisfied</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Somewhat unsatisfied</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Very unsatisfied</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Did you feel that the handoff was rushed?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not at all</td>
<td>12</td>
<td>18</td>
<td>0.2594</td>
</tr>
<tr>
<td>A little rushed</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Somewhat rushed</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Very rushed</td>
<td>0</td>
<td>0</td>
<td></td>
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</tbody>
</table>
Appendix O

Adherence to Tool Use

<table>
<thead>
<tr>
<th>Pod</th>
<th>Button Used?</th>
<th>Pre-Intervention Button Use Count</th>
<th>% of Use</th>
<th>Post-Intervention Button Use Count</th>
<th>% of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>N</td>
<td>1218</td>
<td>99.10</td>
<td>1185</td>
<td>96.37</td>
</tr>
<tr>
<td></td>
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<td>11</td>
<td>0.90</td>
<td>40</td>
<td>3.27</td>
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<tr>
<td>3</td>
<td>N</td>
<td>878</td>
<td>99.32</td>
<td>811</td>
<td>99.14</td>
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<tr>
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<td>98.55</td>
<td>1044</td>
<td>97.48</td>
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<td>1.45</td>
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