A Standardized Approach to Intraoperative Anesthesia Handoffs: Introducing the AMPLE Approach.

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Abstract

Transfer of the care of a patient between healthcare providers occurs frequently during the perioperative course. The typical course of patient movement includes transfer from the preoperative area to the operating room to the postoperative area, patient-specific data is transferred multiple times between healthcare providers. This transfer of data is commonly referred to as a handoff. Literature consistently demonstrates that the use of a standardized checklist improves handoff communication. Despite the literature, most anesthesia practices have been slow to adopt a standardized approach to handoff communication. In this quality improvement project, a standardized checklist was developed through a literature review and expert consensus. Once the checklist was finalized, education was provided to users and it was implemented into the electronic medical record. Participants were then surveyed both pre-implementation and post-implementation to assess handoff practices. A pre- and post-implementation retrospective chart review was also conducted to assess documentation of handoff events and checklist usage. Analysis of the data demonstrates that the development and implementation of the new checklist, compared to the rudimentary checklist that was previously available, improved both documented handoff events and participant satisfaction with the handoff process. Comparing the pre- and post-implementation periods, documented intraoperative handoffs with the use of a checklist improved from less than 1% to 77%, and clinicians reported that there was a significant positive change in the handoff process when compared to the previous process without a checklist. These results, which are consistent with previous studies, suggest that the use of a simple checklist can improve handoff communication and provider satisfaction.

Introduction

Background

Well-conducted handoffs are critical for information exchange that enables relieving clinicians to provide care with the same factual and tacit knowledge of the patient as each and every previous provider (Lornic, 2017). The Joint Commission Center for Transforming Healthcare (2005) has reported many problems associated with ineffective handoffs, including delayed or inappropriate treatment, adverse events, increased length of hospital stay, and increased costs. Additionally, in an observational study, Halterman et al. (2019) found that handoffs are frequently inadequate, and that vital patient information may be left out. Overall, The Joint Commission estimates that 80% of serious medical errors involve miscommunication between caregivers during the transfer of patients (Joint Commission Center for Transforming Healthcare, 2012).

In the years that have followed since the 2006 Patient Safety Goals were published, there have been multiple studies demonstrating the effectiveness of the implementation of a standardized anesthesia handoff tool (Halladay, 2019). However, despite recommendations from the Joint Commission and the literature, most anesthesia practices have been slow to adopt the process. In fact, many anesthesia practices have yet to implement any form of a standardized handoff process leaving patients at increased risk (Agarwala et al., 2015).

Problem statement

Despite general consensus from the literature that the use of checklists improves handoff communication most anesthesia practices have yet to integrate their use into handoff communication (Agarwala, 2015). Prior to the implementation of a checklist this authors

anesthesia practice did not have a standardized approach to the intraoperative handoff process. As a result, there had been several instances where inadequate handoffs had led to improper patient care. These events included failure to properly administer antibiotics during a prolonged surgical procedure, failure to recognize and treat hemorrhage in an obstetric patient, and additional medication errors. The identified contributing factors to these incidents included the rudimentary handoff tool in the electronic medical record, complacent anesthesia providers, and distraction within the environment. The previous intraoperative handoff tool that was available within the electronic medical record was woefully inadequate. Specifically, the previous handoff tool was not interactive, did not include the use of a checklist, and failed to gain widespread acceptance amongst users. This was compounded by the fact that many anesthesia providers have an attitude of complacency when it comes to handoffs. This complacency has led to the practice of haphazard handoff communication. Handoffs are often completed while still providing task-dense patient care (Lornic, 2017). All these factors contribute to poor handoffs and increased risk for our patients.

Organizational Gap Assessment

The target group for this project were Certified Registered Nurse Anesthetists (CRNA) practicing at St Vincent Mercy Medical Center. St Vincent Mercy Medical Center is a medical center that is committed to excellence through both healthcare education and research. This organization has learners across every subspecialty within the hospital, including nursing. They have already allocated resources and developed a culture that removes barriers to education, research, and quality improvement. The organization is motivated to improve care as a part of the culture of excellence that has already been established. Organizational leadership is well aligned with improvement again as a part of the culture of excellence.

Prior to the implementation of a checklist, the handoff process was a verbal report that would contain the information that the outgoing CRNA felt was essential to share with the incoming CRNA. The process was haphazard and disorganized, which created opportunities for incomplete handoffs and communication failures. In the desired state the handoff process would use a checklist to streamline data transfer from the outgoing CRNA to the incoming CRNA. The use of a checklist would standardize the information that was shared during the handoff process.

Despite recommendations from the Joint Commission and the literature, most anesthesia practices have been slow to adopt the process (Agrawala et al., 2015). Prior to the implementation of a checklist, this author's current practice did not have a standardized approach to the intraoperative handoff process. There was an intraoperative handoff tool available in the electronic medical record, but it was woefully inadequate. The tool was not interactive, did not include the use of a checklist, and never gained widespread acceptance amongst users. This tool was developed without input or buy-in from the key stakeholders. Prior to implementation, the tool was not presented to users, and education on its use was not provided. In summary in the previous state, the intraoperative handoff process was inadequate, haphazard, and disorganized which can increase the risk of handoff failures.

Proposed solutions to this problem included refining the current tool or developing a new tool. Both of the possible solutions were feasible and acceptable however the literature would suggest the standardization of all handoffs (Gabot, 2022). The proposed action plan included the development of a standardized checklist based on previously published checklists (Wright, 2013). After the development of the checklist, it was presented to a focus group of anesthesia providers for approval and to facilitate buy-in. After the new handoff checklist was finalized and prior to implementation, educational sessions were held to introduce the checklist, the

appropriate use of it, and its functionality within the EMR prior to implementation. Visual cues were also placed in the anesthesia workspaces to encourage use. Resource requirements for the action plan were minimal. Educational sessions were held during dedicated meeting times.

Review of the Literature

A search of the literature was performed primarily using the PubMed database. Search terms included handoff, handover, checklist, transfer of care, communication, and patient safety. Studies that used nonoriginal handoff tools were excluded. The remaining abstracts were then reviewed for possible inclusion and relevance. When applicable, reference sections were reviewed to identify additional research. Once the abstract review process concluded, all studies, 35 in total, were reviewed for a detailed description of a standardized tool.

Transfer of care between healthcare providers occurs frequently during the perioperative course. The typical course of patient movement includes transfer from the preoperative area to the operating room to the postoperative area. During this course of movement, patient-specific data will be transferred multiple times between healthcare providers. This transfer of data is commonly referred to as a handoff. Patient handoff is the process of exchanging pertinent information through verbal and nonverbal communication and the transfer of professional accountability and responsibility from one provider to another (Gabot et al., 2022) Handoffs frequently occur between various healthcare providers who assume accountability and responsibility for the patient as they move through the perioperative course. In the operating room, a CRNA might handoff care to another CRNA multiple times during a lengthy anesthetic administration. Additionally, a CRNA tasked with providing duty breaks may give and receive multiple handoff communications during a short period of time. Giving and receiving multiple

handoffs may increase the opportunity for communication failure. This may also affect the CRNA's ability to quickly and correctly recall multiple patient comorbidities, allergies, or other vital patient information (Jayaswal et al., 2011). To complicate matters these handoffs frequently occur while the CRNA is completing tasks in a high-pressure work environment (Lowe, 2017).

The operating room (OR) is a complex environment that is full of distractions. These distractions include auditory, visual, communication, equipment, and environmental issues (Nasri et al, 2022). These distractions can adversely affect vigilance, and situational awareness, and pose a risk to patients' safety (van Pelt & Wagner, 2017). In a recent survey of the healthcare team auditory distractions were ranked as the most distracting category during times of critical work (Nasri et al, 2022). These critical work periods that occur during times of increased ambient noise levels can contribute to inadequate handoff communication (Arabacı, 2021). The effects of an increased noise level in the OR have been studied in anesthesia providers and has been shown to negatively impact mental efficiency and short-term memory (Gui et al, 2020). Combining the effects of distraction while still providing task-dense patient care can affect provider communication while compromising patient safety (Lornic, 2017). The use of a checklist is recommended in the literature to overcome these distractions (Agarwala, 2015).

The Joint Commission Center for Transforming Healthcare (2005) reported many problems associated with ineffective handoffs such as delayed or inappropriate treatment, adverse events, increased length of hospital stay, and increased costs are the result of ineffective handoffs. It has been noted in observational studies that handoffs are frequently inadequate, and that vital patient information may be left out (Halterman et al, 2019). The Joint Commission estimates that 80% of serious medical errors involve miscommunication between caregivers

during the transfer of patients (Joint Commission Center for Transforming Healthcare, 2012). Saager et al. (2014) examined the relationship between anesthesia handoffs and in-hospital morbidity and mortality. In examining 130,000 patients it was shown that as few as one handoff during the surgical course increased the risk of in-hospital morbidity and mortality. As the number of handoffs increased so did the risk of morbidity and mortality (Saager et al., 2014). Also, Harvard Medical Institutions found that communication failures were at least partially responsible for 1700 deaths and $1.7 billion in malpractice costs over five years (The Risk Management Foundation of the Harvard Medical Institutions, Inc. 2015).

In 2006 The Joint Commission made handoff communication a National Patient Safety Goal. Goal statement 2E states that practices should implement a standardized approach to handoff communication including an opportunity to ask and respond to questions. In the goal statement, individual organizations were directed to implement a standardized process. This standardized process must be well-defined, communicated to the staff, and implemented in a timely manner (Joint Commission Center for Transforming Healthcare, 2017).

In the years that have followed the 2006 Patient Safety Goal, there have been multiple studies demonstrating the effectiveness of the implementation of a standardized anesthesia handoff tool (Halladay et al, 2019). However, despite recommendations from the Joint Commission and the literature, most anesthesia practices have been slow to adopt the process (Agarwala, 2015). In fact, many anesthesia practices have yet to implement any form of a standardized handoff process leaving patients at increased risk.

In reviewing the literature, it is clear that most standardized handoff tools use an acronym or mnemonic (Wright, 2013). In 2013 Wright developed an early version of one such mnemonic tool, the PATIENT protocol. Building upon the PATIENT protocol, Gibney et al. (2017)

developed the TIME anesthesia handoff tool. There are many more examples of handoff mnemonic tools in the literature including IPASS (Starmer et al, 2020), WHAT (Lambert & Adams, 2018), and SBAR (Halterman et al, 2019). Mnemonics allow the learner to engrain a pattern for repeated retrieval of information. This pattern of repeated retrieval promotes the standardization of information that is transferred.

There is a significant body of literature to support the use of standardized handoffs for nurse anesthetists (Gabot et al, 2022). Standardization of handoffs has been shown to reduce omissions in data transfer and improve complete handoffs (Halterman et al, 2019). For example, Agarwalla et al. (2015) demonstrated that the use of a standardized tool improved post-handoff retention of information while also improving satisfaction in the handoff process in anesthesia providers. In summary, it is clear that the adoption of a standardized approach through either the use of a mnemonic handoff tool or checklist improved data transfer during handoffs. The data demonstrates that despite clear evidence of it being a superior technique a majority of practitioners do not use a standardized approach to handoff. The data also shows that the use of a checklist significantly improves information transfer and information retention during handoff (Agarwala et al, 2015). Failure to relay essential data during handoffs has been associated with patient harm.

Evidence-based Practice: Verification of Chosen Option

The purpose of this quality improvement project was aimed at reducing communication failures and incomplete handoffs during intraoperative transfers of care from CRNA to CRNA. The project sought to answer the PICO question: In Certified Registered Nurse Anesthetists practicing at St Vincent Mercy Medical Center does the use of a standardized checklist during intraoperative handoffs improve handoff communication and satisfaction with the process. In the

review of the literature, the evidence was clear evidence-based practices supports the use of standardization and the use of a checklist. The model that was used for this quality improvement project is the Plan Do Study Act (PDSA) model.

Theoretical Framework

Handoff failures can directly lead to events that can compromise patient safety. A major stressor for patients undergoing surgery is a concern for their personal safety. By improving the handoff process, we can improve patient safety. Imogen King's theory of goal attainment can be used to guide this project. King's theory of goal attainment (Seiloff & Messmer, 2014) identifies four universal ideas: social systems, health, perception, and interpersonal relationships. According to King nursing is a process of interactions that lead to actions and reactions. The actions and reactions lead to goal attainment and goal attainment is a measure of effective nursing care. Within the interaction, the nurse and patient share information about their perception of the nursing situation. A key element of the theory is the ability of the nurse and the patient to interact and communicate. In the process of interaction both the nurse and patient must make judgments to establish and set mutual goals (Seiloff & Messmer, 2014). In the process of goal setting both the nurse and patient must identify any potential disturbances that will compromise reaching the mutual goals. Within this project, the disturbance is the lack of a standardized handoff process that compromises patient safety.

In anesthesia practice, the nurse and the patient have the ability to interact in the preoperative phase of care. This is generally the first time the patient and nurse are introduced to each other; it is the beginning of the nursing relationship. It is in this initial interaction, the preoperative evaluation, the CRNA and the patient review the surgical plan and the patient's medical history. They also discuss various anesthesia techniques that are appropriate for the

surgical procedure. In this process, the anesthesia care plan is formulated and there is a discussion of the associated risks and benefits. Many patients do not directly express their concerns about personal safety; however, it is often implied and understood. After both the CRNA and the patient have identified their concerns, and perceptions, and set mutual goals, they must identify any potential disturbances. A disturbance can be defined as an interruption of a settled and peaceful condition (Seiloff & Messmer, 2014). The CRNA has identified that poor handoffs cause harm and that the lack of a standardized process contributes to poor handoffs, this is the disturbance.

Once the disturbance has been identified the CRNA would move into the action phase of the theory. In the action phase, the CRNA and patient collaborate to set mutual goals. In this setting, the mutual goal of maintaining patient safety throughout the surgical course is set. In setting mutual goals, the CRNA is now propelled into action to identify interventions that will help them and the patient achieve their mutually set goal, a standardized handoff process. Through the development of a standardized approach, the CRNA can minimize the risks of anesthesia handoffs and achieve the mutually set goal of safely navigating the perioperative course. The use of King's theory of goal attainment would allow the nurse to improve the care and safety of the patient. See appendix A for the concept map for this project using King's Goal Attainment theory.

Goals and Objectives

The primary goal of this project was to demonstrate an increase in the number of documented intraoperative handoff events with the use of a standardized checklist. The secondary goal was to improve CRNA satisfaction with the handoff process. Identified

facilitators for this project included leadership within the anesthesia department. The medical director and chief CRNA were both supportive of this quality improvement project. Barriers to success included complacency with handoffs and resistance to changing the previous handoff practice. To promote success efforts were made through focus groups and educational sessions to obtain buy-in from key stakeholders to overcome the identified barriers.

The Identified Goals were:

1) Determine the essential components of the handoff checklist through synthesis of the literature and peer review
2) Focus group session to review and approve the checklist
3) Integration of checklist into EMR by Mercy Health Systems EPIC specialist
4) Pre-implementation survey distributed via Qualtrics survey tool
5) Educational sessions times 3 on handoff failures, the importance of checklist use, functionality within EMR, sessions in PowerPoint format
6) Visual cues to be placed in anesthesia workspaces
7) Additional booster educational sessions will be provided two weeks after implementation.
8) Postimplementation survey distributed via Qualtrics survey tool
9) Retrospective chart review to determine use of the checklist

Methods

This quality improvement study was approved by the University of Alabama's and the St Vincent Mercy Medical Center's Institutional Review Board. The setting for this project was a three-hundred-and-fifty-bed medical center located in Northwest Ohio. This medical center

provides a wide variety of surgical services for adult patients. Prior to this project, the setting did not have a standardized approach for the intraoperative handoff process. The previous intraoperative handoff tool that was available within the electronic medical record was woefully inadequate. The previous tool was not interactive, did not include the use of a checklist, and failed to gain widespread acceptance amongst users. There was an identified need for an improved process.

After a review of the literature was completed the essential components or information that were deemed necessary for intraoperative handoff communication were identified. These components were then organized into a sequence that favored the use of an acronym. It was identified in the literature review that most standardized handoff tools use an acronym or mnemonic (Wright, 2013). In keeping with this theme, the AMPLE checklist was developed. In the AMPLE checklist, the five letters in the acronym guided users through a ten-item standardized checklist, see appendix B. The items in the AMPLE checklist were deemed the essential components that should be relayed in intraoperative handoffs based on the literature review. Once the AMPLE checklist was developed it went through a peer review process and expert consensus was used to further refine the checklist.

Project Design

The purpose of this quality improvement project was to reduce the incidence of inadequate handoffs during intraoperative transfers of care from CRNA to CRNA through the use of a standardized checklist. The primary goal of this quality improvement project was to increase the use of a standardized checklist during intraoperative transfers of care. A secondary goal was to demonstrate improved satisfaction of the CRNA providers with the new

process. Data collection included both a pre-implementation and post-implementation survey that was distributed to consenting CRNA's of the anesthesia department. The goal of the pre-implementation survey was to establish current practice. A pre-implementation retrospective chart review was performed to assess handoff documentation. After the implementation of the AMPLE checklist into the EMR and prior to implementation, educational sessions reviewing the new tool and the importance of a standardized approach to intraoperative handoffs were provided to the applicable staff members. Visual cues were also placed on the anesthesia machine to provide a visual reminder and to prompt the use of the new tool. See appendix C for an example of the visual cue. Post-implementation, a retrospective chart review to evaluate the use of the new tool and the completeness of the documented handoff was conducted. A post-implementation survey was also completed by the providers to evaluate subjective usage of the new tool and to measure satisfaction with the new process. Descriptive statistics were used to analyze the survey data.

Project Site and Population

The setting for this project was a three-hundred-and-fifty-bed medical center located in Northwest Ohio. This medical center provides a wide variety of surgical services for both pediatric and adult patients. The project-setting leadership are motivated to improve care as a part of the culture of excellence that has already been established. Organizational leadership is well aligned with improvement, again as a part of the culture of excellence. See appendix D for the letter of support.

The retrospective chart review component of the study involved an adult (non-obstetric) patient population. The anesthesia department consists of both anesthesiologists and CRNA's.

The identified key stakeholders for this project are the CRNA's as they are the direct anesthesia providers. Inclusion criteria for this project included certified registered nurse anesthetists that have current hospital credentials. Exclusion criteria were nurse anesthetists that rarely practice at this location (i.e., less than two times a month).

Measurement Instruments

All survey questions had a five-point Likert scale response, ranging from always to never and strongly agree to strongly disagree. The surveys were based on existing instruments that examined nurse anesthetists standardized intraoperative handoffs (Gabot, 2022). See appendixes E and F for the survey instruments.

Data Collection Procedures

The model that was used for this quality improvement project was the Plan Do Study Act (PDSA) model. In the planning phase, a standardized handoff tool was developed for implementation into the electronic medical record (EMR). The AMPLE checklist was developed through literature review and peer review. Prior to the implementation of the AMPLE checklist into the EMR, certified registered nurse anesthetists were surveyed to establish baseline attitudes and beliefs regarding the current state of handoff practices. Surveys were distributed via email and collected through the Qualtrics online survey tool. Subjects were then surveyed post-implementation of a standardized checklist to measure the impact on provider satisfaction with the new checklist. The survey instruments are based on existing instruments that examined nurse anesthetists standardized intraoperative handoffs (Gabot, 2022). Survey questions were modified to best fit the study site and population. See appendixes E and F for the survey questionnaires. Survey responses were measured using a Likert-type scale. The surveys utilized a five-point

ordinal response for analysis: strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree. Additional ordinal categories included always, often, sometimes, rarely, and never. Each response category was assigned a numerical value for analysis, strongly agree and always (5), agree and often (4), neither agree nor disagree and sometimes (3), disagree and rarely (2), strongly disagree and never (1). The pre-implementation survey was distributed via the Qualtrics survey tool a month prior to the implementation of the standardized handoff tool via the Qualtrics survey tool. Participants had two weeks to complete the survey. The post-implementation survey was distributed six weeks post-implementation of the new standardized handoff tool. Participants again had two weeks to complete the survey. Surveys were sent to participants using their employer-sponsored email addresses. Surveys were returned anonymously. Survey participants created their own unique user identification (ID) to facilitate the pairing of the pre- and post-survey data. Pre- and post-implementation survey data were analyzed using a paired T-test. Data from pre-implementation survey questions 2-6 were paired with post-implementation survey questions 2-6. Additional survey question including demographic information was analyzed using descriptive statistics.

In the do phase, the handoff tool was implemented into the EMR. After implementation into the EMR and prior to go live there were educational sessions reviewing the new tool and the importance of a standardized approach to handoffs. Visual cues were placed on the anesthesia machine to provide a visual reminder and prompt the use of the new tool. In the study phase, there was a retrospective chart review to evaluate the use of the new tool and the completeness of the documented handoff. Data on the use of the checklist was collected retrospectively from the EMR both pre- and post-intervention. See appendix G for the retrospective chart review data collection tool. Pre-implementation data collection evaluated all anesthesia records that occurred

within the four weeks prior to the implementation of the checklist. Post-implementation of the checklist users were given a week to become accustomed to the tool (Halterman et al, 2019). Post-implementation data collection began one week after the implementation of the checklist into the EMR and evaluated all anesthesia records that occurred within the following four weeks. The frequency of intraoperative handoffs can vary from day to day based on many different factors that include case mix, surgical volume, and staffing. The four-week timeframe was chosen for data collection to ensure that the sample size was large enough to determine significance. Within the defined time periods the EMR system was queried to identify anesthesia records in which a handoff occurred based on billing data. If more than one handoff occurred during the course of anesthesia care, then the first handoff was used, and any others were excluded. In the project setting, surgical cases tend to be complex and lengthy leading to numerous handoffs. Given the scope of this project, it was determined to only evaluate the first documented handoff which is supported in the literature (Agarwala et al, 2015). Therefore, if more than one handoff occurred during the course of anesthesia care, only the first handoff was used, and any others were excluded.

Once the anesthesia records were identified as containing a transition in care, these records were reviewed for the documentation of a handoff within $\pm$15 minutes of the time-stamped transition of care. If no documentation was present, then the handoff was classified as having occurred without the use of a checklist. A handoff with no documentation was scored as a zero on the chart review data collection tool. A handoff with documentation was scored as a one on the chart review data collection tool. The use of the checklist was analyzed using descriptive statistics comparing the number of documented handoffs versus the number of identified handoffs based on billing data (Agarwala et al, 2015). Further analysis of the checklists included

a review of components of the checklist that were not documented. Missing items were noted individually on the chart review data collection tool. The total number of checklist items used was also documented on the chart review data collection tool. Missing items from the checklist during handoff were analyzed using descriptive statistics. Once data analysis was completed, user feedback was evaluated to validate the tool or determine if additional changes are needed (Act).

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Data Analysis

Pre- and post-implementation survey data was analyzed using both a paired T-test and descriptive statistics. Data from the pre-implementation survey, questions 2-6 were paired with the post-implementation survey questions 2-6. Additional survey question results were analyzed using descriptive statistics. Descriptive statistics along with a frequency distribution were used to compare the data from documented handoffs in the EMR both pre- and post-intervention.

Cost Benefit Analysis

There was a minimal cost involved in this quality improvement project while the benefits have been well established in the literature.

Timeline

The total timeframe for this project spanned the course of a year. Please see appendix H for a detailed timeline.

Ethical Considerations

The University of Alabama and the St Vincent Mercy Medical Center Institutional Review Board (IRB) approved this project. All participants in this in this quality improvement project provided informed consent to participate in pre- and post-implementation surveys. The survey participants submitted their responses anonymously through Qualtrics. All charts that were reviewed were protected by the Health Insurance Portability and Protectability Act (HIPPA) of 1996. Among other things, HIPPA guarantees the protection of identifiable health information. In this retrospective review no protected health information was collected, only documentation of handoff and use of checklist was evaluated and recorded. All standards of anesthesia care were continued during the intraoperative anesthesia handoff.

Results

A retrospective chart review was completed to evaluate all anesthesia records for the four weeks preceding the implementation of the AMPLE checklist (the pre-implementation period). Within the EMR a search was completed to generate all anesthesia records completed in the four-week timeframe. All anesthesia records were then manually reviewed to determine if there was an intraoperative transition in care, a handoff, based on the billing data. Once the anesthesia records were identified as containing a handoff, these records were further reviewed for the documentation of a handoff event within $\pm$15 minutes of the time-stamped transition of care. Given the scope of this project, it was determined to only evaluate the first documented handoff, as described in previous studies (Agarwala et al, 2015). Data analysis of the retrospective chart review employed the use of descriptive statistics. Within the defined four-week timeframe there were 1001 anesthetics performed. Of the 1001 anesthesia records identified 306 contained an intraoperative anesthesia handoff based on billing data. Further scrutiny of the 306 anesthesia

records revealed that 3 contained a documented handoff event, which yielded an overall rate of 0.98% in the pre-implementation period.

Another retrospective chart review was completed for the four weeks post-implementation of the AMPLE checklist. Within the electronic EMR, a search was completed to generate all of the anesthesia records that were performed within a four-week time frame. All anesthesia records were manually reviewed to determine if there was an intraoperative transition in care, a handoff, based on the billing data. Within the defined four-week timeframe there were 1005 anesthetics performed. Of the 1005 anesthesia records, 200 were identified to contain an intraoperative anesthesia handoff based on billing data. Further scrutiny of the anesthesia records that contained a handoff demonstrated that 154 of the 200 (77%) contained complete documented use of the AMPLE checklist. The post-implementation data demonstrated a significant increase in the documentation of handoff events with the use of the AMPLE checklist. The sample change in response rates, post-implementation minus pre-implementation is 0.760, thus an increase in documentation rate of 76%. The corresponding 95% confidence interval is (0.701, 0.820). Using Fisher's exact test, we found a significant ($p < 0.001$) increase in the rate of handoff using a checklist between the pre- and post-implementation periods. See Table 1. Thus, we conclude that the implementation of the AMPLE checklist – and the corresponding educational training – resulted in a significant increase in handoff documentation.

Table 1

Descriptive Statistics for Pre/Post Checklist Tool

Sample	N	Event	Sample p
Sample 1	306	3	0.009804
Sample 2	200	154	0.770000

Estimation for Difference			
Difference		95% CI for Difference	
-0.760196		(-0.819555, -0.700837)	
Method		p-Value	
Normal Approximation		0.000	
Fisher's Exact		0.000	

Analysis of the checklist usage included a review for documentation of each individual item of the 10-item checklist. Missing items were then noted individually on the chart review data collection tool. Of the 160 documented uses of the AMPLE checklist, 154 (96%) had complete use of the checklist with no missing items. A review of the remaining six that were incomplete demonstrated that 2 were completely blank, 2 missed EBL and fluid replacements, 1 missed anesthesia type, and 1 had multiple missing components.

Pre- and post-implementation survey data were analyzed using both a paired T-test. The response rate for the pre-implementation survey was 20 out of 27 or 74%. The response rate for the post-implementation survey was 26 out of 27 or 96%. In reviewing the completed pre- and post-surveys, 16 of the unique user IDs matched and were therefore used for paired data analysis. See Table 2. Paired sample t-tests were utilized to compare participant assessment of handoff quality. For question 7 which inquired as to the intent to continue to use the AMPLE checklist after the completion of the project, there was not a pre-implementation question to pair the data. Analysis of the survey data demonstrated a statistically significant difference (an increase in

satisfaction for questions 2, 3, 4, and 6, and a decrease in fallibility for question 5) between the pre- and post-implementation time periods.

Table 2

Paired Sample t-tests for Pre and Post Questions 2 through 7.

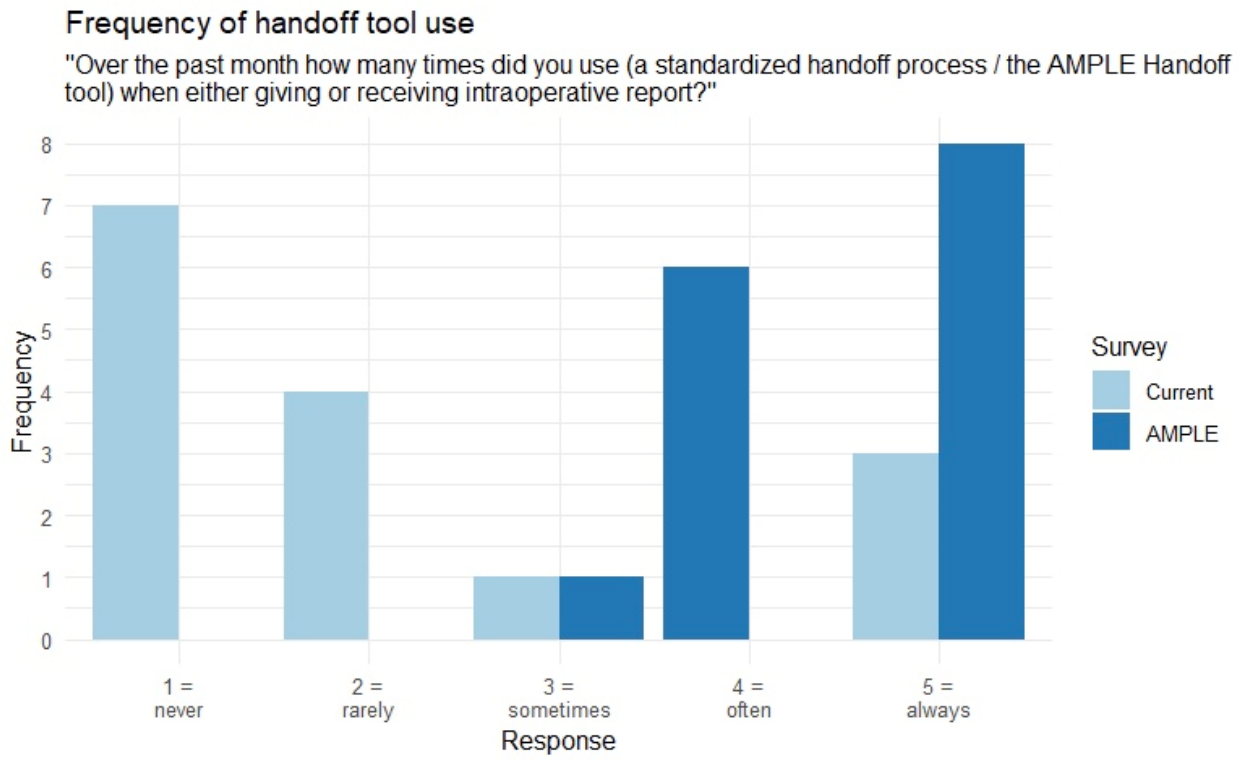
Item		Mean	SD	t	df	p-val (2-tailed)
Q2	Diff	2.267	1.534	5.724	14	0.000
	Pre	2.200	1.568			
	Post	4.467	0.640			
Q3	Diff	1.125	1.408	3.195	15	0.006
	Pre	3.250	1.125			
	Post	4.375	0.806			
Q4	Diff	1.375	1.310	4.198	15	0.001
	Pre	2.938	1.181			
	Post	4.313	0.704			
Q5	Diff	-1.000	1.033	-3.873	15	0.001
	Pre	3.438	0.814			
	Post	2.438	1.031			
Q6	Diff	1.063	1.181	3.597	15	0.002
	Pre	3.188	0.911			
	Post	4.250	0.775			
Q7	Post	4.250	0.856			

Pre-intervention survey Question 2 demonstrated that a majority of respondents (73%) rarely or never use a standardized approach to intraoperative handoff communication. The post-intervention Question 2 data demonstrates that a majority of respondents (93%) reported using the AMPLE checklist to facilitate intraoperative handoff communication. See Table 3. Paired sample t-test showed a statistically significant increase in the use of a standardized approach from pre-question 2 (M= 2.2, SD= 1.5) to post-question 2 (M= 4.4, SD= 0.64,) t (14) = 5.724 P =0.000.

Survey questions 3, 4, and 6 also demonstrated a significant positive change with p-values in the range of 0.000 to 0.006, see table 2. In evaluating how effective the handoff process is in transferring patient-specific information the post-intervention data demonstrates that a majority (93%) of respondents agreed that the AMPLE checklist provided an effective way to transfer important patient information. Regarding how comprehensive the handoff process was, positive responses increased from 33% to 80% for the AMPLE checklist. Regarding how appropriate the handoff process was positive responses increased from 40% to 93% for the AMPLE checklist.

Table 3

Pre-Intervention versus Post-Intervention Handoff Tool Use



Survey questions 3, 4, and 6 also demonstrated a significant positive change with p-values in the range of 0.000 to 0.006 (See Table 2). In evaluating how effective the handoff process is in transferring patient-specific information the post-intervention data demonstrates that a majority

of respondents (93%) agreed that AMPLE checklist provided an effective way to transfer important patient information. Regarding how comprehensive the handoff process was, positive responses increased from 33% to 80% for the AMPLE checklist. Regarding how appropriate the handoff process was positive responses increased from 40% to 93% for the AMPLE checklist.

Due to the negative nature of Question 5, the current process/AMPLE handoff tool lends itself to mistakes, there was a statistically significant decrease from the pre- to post-implementation survey results. Pre-intervention Question 5 data demonstrated that 46% of respondents believed that the current process lends itself to mistakes. Post-intervention Question 5 data demonstrated that a majority of respondents (53%) disagreed when questioned if the AMPLE checklist lends itself to mistakes. See Table 5. All data analysis was completed using R software. The demographic data collected is displayed in Table 6.

Table 5

Pre-Intervention versus Post-Intervention Handoff Fallibility

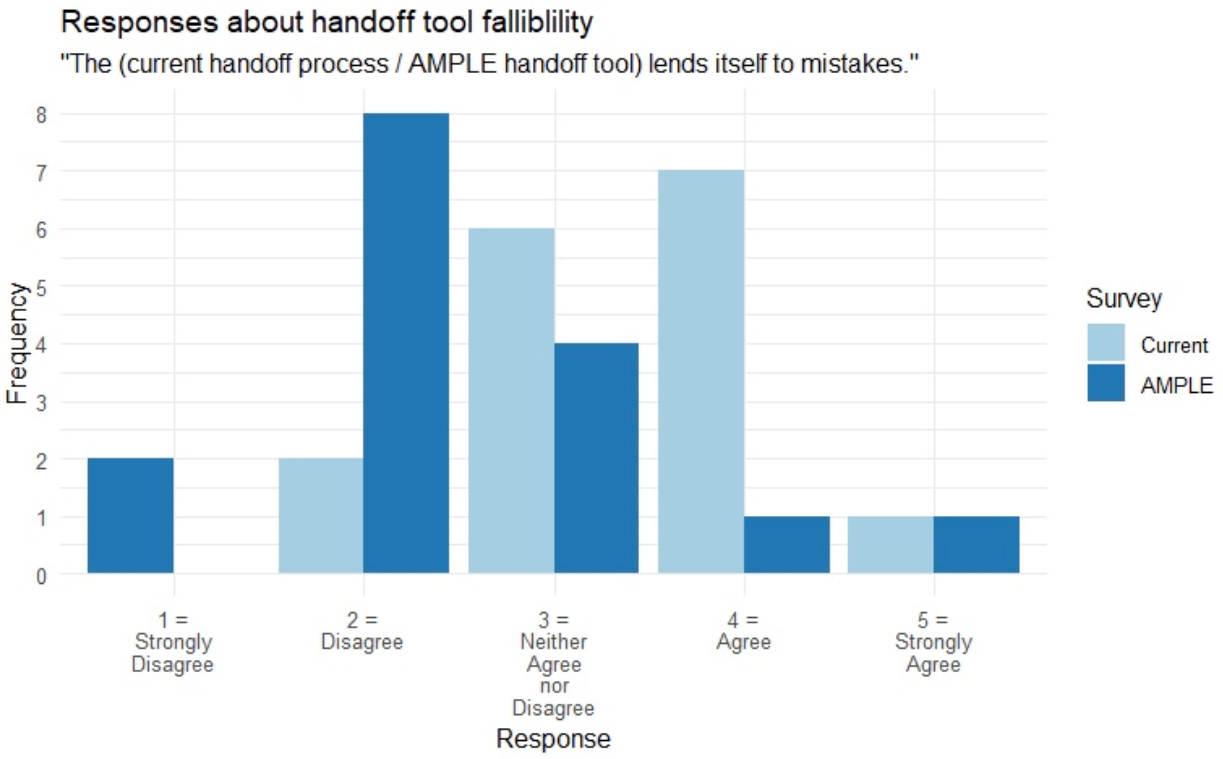


Table 6

Demographic Survey Data

Experience	Count	Average Hours worked per week	Count
0-5 Years	8	52	1
6-10 Years	3	50	5
11-15 Years	0	45	1
16-20 Years	1	40	6
21 Years or more	4	36	1
		32	1
		24	1

Interpretation/Discussion

The primary goal of this project was to demonstrate an increase in the number of documented intraoperative handoff events with the use of a standardized checklist. The secondary goal was to improve CRNA satisfaction with the handoff process. Implementation of the AMPLE checklist promoted a dramatic improvement in the documentation of intraoperative anesthesia handoffs with the use of the checklist. Survey data demonstrated that a majority of participants reported that they found the checklist improved the handoff process in several aspects. Participants also reported that they intend to continue to the AMPLE checklist after the completion of this project.

Post-implementation survey data demonstrated that the AMPLE checklist improved the effectiveness of data transfer, was more comprehensive, and was more appropriate than the pre-implementation state. Descriptive analysis of questions 2, 3, 4, and 6 demonstrated a significant increase in positive responses. Paired sample t-tests of the same questions also demonstrated statistically significant improvements with the use of the AMPLE checklist, as compared with the previous, very rudimentary, checklist. These results are consistent with previously published literature examining the use of a standardized approach to handoff (Gabot, 2022). Analysis of the retrospective chart review data also demonstrated a significant increase in both the documentation of handoff events and the use of a checklist, from less than 1% to 77%. These results are consistent with previously published literature examining the use of a checklist to standardize intraoperative handoffs (Agarwala et al, 2015). Analysis of checklist usage data demonstrated that a vast majority (96%) contained complete documentation with no missing items.

There were several limitations to our project. First to facilitate the use of a paired t-test for data analysis survey participants were provided with directions to create their unique user ID in the pre-implementation survey. Participants were also provided with the same directions to recall

their unique user ID for the post-implementation survey. Despite the instructions provided in the post-implementation survey, many participants could not accurately recall their unique user ID. The inability to pair the surveys reduced the overall survey response rate (i.e., of the 20 participants who completed the pre-implementation survey, 16 were able to have their responses paired with post-implementation surveys).

Also, it is noteworthy that there were significantly fewer handoffs in the post-implementation sample when compared to the pre-implementation sample despite the fact that the total number of anesthesia cases was similar in both groups. Given the unpredictable nature of anesthesia, the frequency of intraoperative handoffs can vary from day to day based on many different factors that include case mix, surgical volume, and staffing. The number of duty breaks, including lunch breaks, are also affected by the presence of student registered nurse anesthetists (SRNA). It is common practice in the project setting that if the CRNA is assigned to a SRNA they will not receive a duty break. During the post-implementation data collection period there were significantly more SRNA's at the site which may explain the difference in the total number of intraoperative handoffs.

Analysis of checklist usage data demonstrated that a vast majority (96%) contained complete documentation with no missing items. The functionality within the EMR promoted users to complete documentation. To complete documentation of the checklist, users were required to click the enter key and then the down arrow in succession through the checklist. In the checklists that contained missing items, 3 of the 6 were missing either the first item or the last item in the checklist. This could be attributed to simple keystroke errors.

Conclusions

The development and implementation of the AMPLE checklist into the EMR for use during intraoperative handoffs improved both documented handoff events and CRNA satisfaction with the handoff process. In this project, documented handoff checklist usage improved from less than 1% during the pre-implementation period to 77% post-implementation, and clinicians reported that there was a significant positive change in their satisfaction with handoff process when compared to the previous process without a checklist. These results, which are consistent with previous studies, suggest that the use of a simple checklist can improve handoff communication and provider satisfaction.

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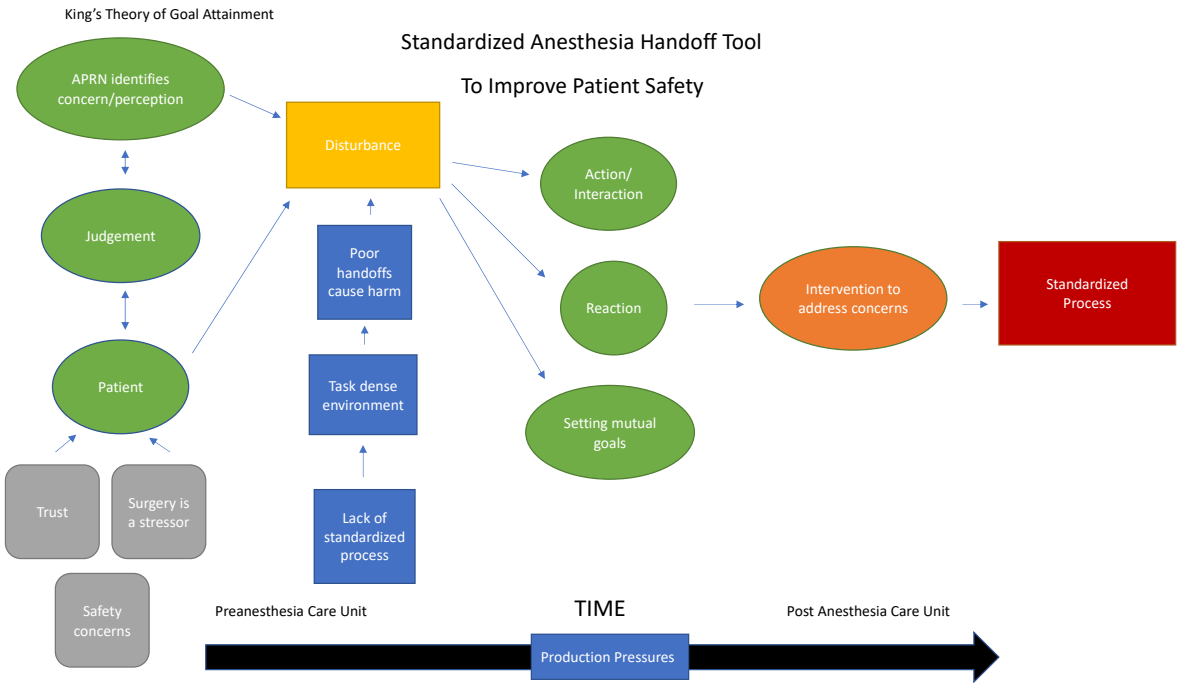
Appendix A

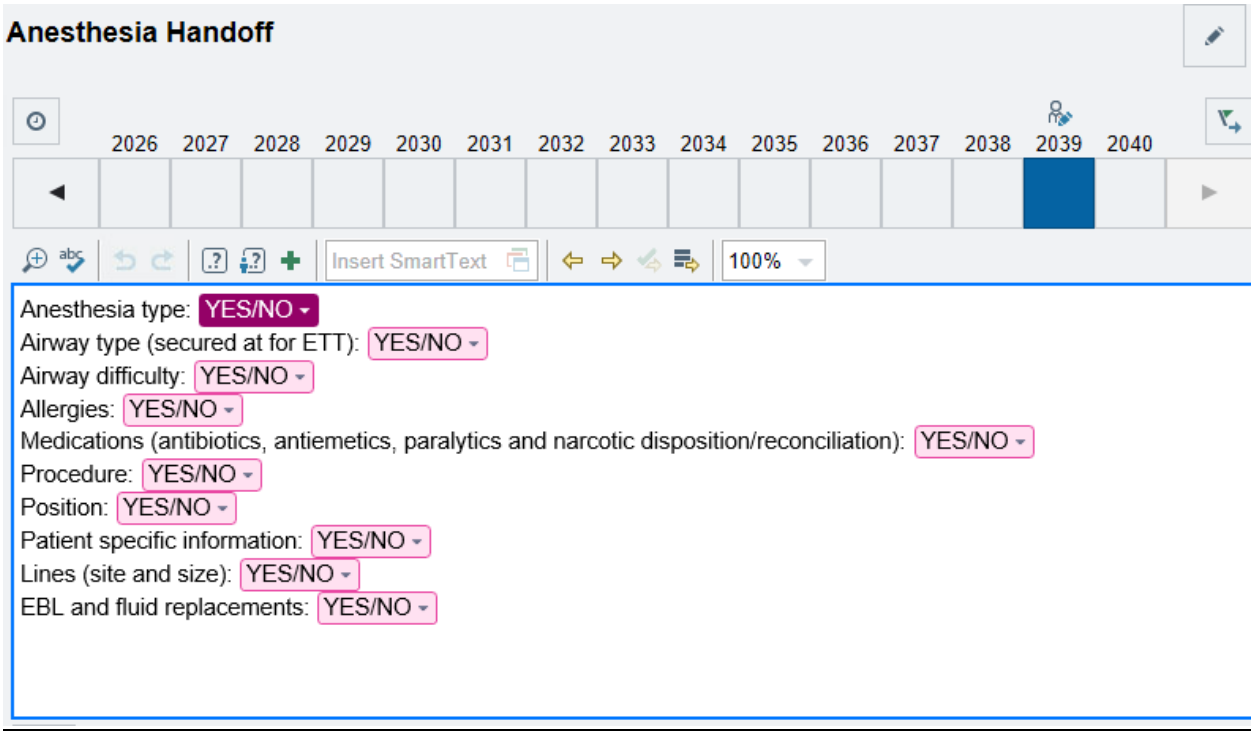
Concept Map



Appendix B

AMPLE Checklist

Essential Components of Handoff Checklist – AMPLE



Appendix C

Visual Cue

Have you given an AMPLE handoff??

- Anesthesia type
- Airway type
- Airway difficulty
- Allergies
- Medications
- Procedure
- Position
- Patient Specific Information
- Lines (site and size
- EBL and Fluid Replacements

Appendix D

MERCYHEALTH

Miguel A. Morillo, MD, MBA
Chief Medical Officer MSVMC
BSMH Acute Care Chief Medical Officer Toledo, OH

2213 Cherry St
Toledo, OH 43608
419-251-3592

Date: August 22, 2022

Dear Ms. Sue Henderson, CCRC,

After meeting with Mr. Montrie, careful review and consideration of his project's details and objectives, I opine our patients and the Ministry would benefit from the development of a standardize approach to "Intraoperative Anesthesia Hand Off" . Therefore, I have decided to support and authorize Mr. Montrie to conduct his research project at our institution. I look forward to the advancement it will bring to the quality and safety of our patients.

Yours Sincerely,

Miguel A. Morillo, MD, MBA
Chief Medical Officer MSVMC
BSMH Acute Care Chief Medical Officer Toledo, Ohio

Appendix E
Pre Implementation Survey Questions

1. To preserve the anonymity of your responses and yet allow us to pair your pre implementation and post implementation responses, we will use a unique identifier for each participant. In the space below, please enter the following with no spaces: the first two letters of your mother's maiden name, the day of the month you were born on, the first two letters of the street you grew up on. For example, if your mother's maiden name was Smith, you were born on the 14th, and you grew up on Main street, you would enter "sm14ma." The purpose of providing this format is so that your ID will be naturally recoverable at the time of the post implementation survey, with the same instructions provided. _____

2. Over the past month how many times did you use a standardized handoff process when either giving or receiving intraoperative report.

   Always Often Sometimes Rarely Never

3. The current handoff process provides an effective way of transferring important information.

   Strongly Agree Agree Neither Agree nor Disagree Disagree Strongly Disagree

4. The current handoff process is comprehensive.

   Strongly Agree Agree Neither Agree nor Disagree Disagree Strongly Disagree

5. The current handoff process lends itself to mistakes.

   Strongly Agree Agree Neither Agree nor Disagree Disagree Strongly Disagree

6. The current handoff process is appropriate.

   Strongly Agree Agree Neither Agree nor Disagree Disagree Strongly Disagree

7. How long have you worked as a certified registered nurse anesthetist?

   0-5 years 6-10 years 11-15 years 16-20 years 21years or more

8. On average, how many hours a week do you spend providing anesthesia care as a certified registered nurse anesthetist. _____

Appendix F

Post Implementation Survey Questions

1. To preserve the anonymity of your responses and yet allow us to pair your pre implementation and post implementation responses, we will use a unique identifier for each participant. In the space below, please enter the following with no spaces: the first two letters of your mother's maiden name, the day of the month you were born on, the first two letters of the street you grew up on. For example, if your mother's maiden name was Smith, you were born on the 14th, and you grew up on Main street, you would enter "sm14ma." _____
2. Over the past month how many times have you used the AMPLE handoff tool.

   Always Often Sometimes Rarely Never
3. The AMPLE handoff tool provides an effective way of transferring important information.

   Strongly Agree Agree Neither Agree nor Disagree Disagree Strongly Disagree
4. The AMPLE handoff tool is comprehensive.

   Strongly Agree Agree Neither Agree nor Disagree Disagree Strongly Disagree
5. The AMPLE handoff tool lends itself to mistakes.

   Strongly Agree Agree Neither Agree nor Disagree Disagree Strongly Disagree
6. The AMPLE handoff tool is appropriate.

   Strongly Agree Agree Neither Agree nor Disagree Disagree Strongly Disagree
7. I will continue to use the AMPLE handoff tool when giving report.

   Always Often Sometimes Rarely Never

Appendix G

Chart review Data Collection Tool

Documented handoff within 15 minutes of time stamped transition of care(score as 1) _____

If documented handoff present were the following documented:
Anesthesia type_____
Airway type_____
Allergies_____
Medications_____
Procedure_____
Position_____
Patient specific information_____
Lines (site and size)_____
EBL and fluid replacements_____

Completeness of checklist – Total number completed out of 10_____

No documented handoff within 15 minutes of time stamped transition of care(score as 0)_____

Appendix H

Timeline

1) Determine the essential components of the handoff checklist through synthesis of the literature by 7/1/2022
2) Obtain IRB approval 10/1/2022
3) Focus group session to review and approve the checklist by 10/1/2022
4) Integration of checklist into EMR by Mercy Health Systems EPIC specialist by 10/17/2022
5) Enroll participants and obtain informed consent 10/3/2022 through 10/10/2022.
6) Pre implementation survey distributed via online survey tool 10/10/2022 will close 10/24/2022
7) Educational sessions times 3 on handoff failures, importance of checklist use, functionality within EMR, sessions in power point format (10/12, 10/26, 11/9)
8) Visual cues to be placed in anesthesia workspaces 10/14/2022
9) Additional booster educational sessions 10/26/2022 and 11/9//2022
10) Postimplementation survey distributed via online survey tool 11/21/2022 will close 12/05/2022
11) Retrospective chart review to determine use of checklist 12/16/2022
12) Start data synthesis 1/1/2023
13) Dissemination of data 4/1/2023