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The Effectiveness of an Anesthesia Handoff Tool: An Electronic Health Record Application to Enhance Patient Safety

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Abstract

Perioperative patient care handoffs are complex and multidimensional and require accurate attention to detail. Communication failures among health care providers increase the risk of morbidity and mortality. Use of a standardized handoff tool located within the electronic anesthesia record formalizes the handoff process and improves patient safety. I conducted 82 patient care transfer observations before the introduction of an electronic anesthesia handoff tool and 75 patient care transfer observations subsequent to the launch of the tool and made before and after comparisons. Significantly ($P<0.05$) fewer errors were made in all categories of patient information after the introduction of the electronic anesthesia handoff tool. There were trends toward more handoff omissions after 3:00 PM, but the difference in most patient information categories was not significant ($P>0.05$). In addition, there were no significant differences in omissions related to the severity of patient comorbidities according to American Society of Anesthesiologists physical status classification. These findings provide information regarding the incidence of patient information inaccuracies and omissions during patient care transfer before and after implementation of an electronic patient care transfer tool.

Keywords: anesthesia handoff, electronic health record, patient care transfer

INTRODUCTION

Patient care is transferred from one anesthesia provider to another frequently throughout the day. Ideally, one anesthesia provider would be responsible for the entire perioperative phase for a surgical patient; however, discontinuity of care is inevitable owing to shift changes, meal breaks, and staffing shortages. It is paramount that handoff processes be accurate, thorough, and concise to reduce errors, promote patient safety, and support a busy surgical schedule. Many barriers exist in the surgical environment that threaten the integrity of the handoff process. Such barriers include high background noise, high activity level, provider fatigue, operating room production pressure, interruptions during handoff, and lack of standardization of the handoff process. The critical importance of an accurate handoff and the significance of barriers to effective communication demand that nurse anesthetists develop strategies that contribute to patient safety and limit communication failures.

Failures in communication among health care providers account for 60% of the root causes associated with sentinel events reported annually to the Joint Commission.[1] Transfer of patient care, or "handoffs," in the operating room occur for meal breaks, shift changes, and transfer of patient care to the post-anesthesia care unit or intensive care unit. Jayaswal et al[2] report that transfer of patient care between anesthesia providers occurs at least 5 times per operating room each day between 7:00 AM and 3:00 PM. Since many operating rooms conduct business well past 3:00 PM, the potential for errors and omissions of essential patient information during handoffs is considerable. An added impact to potential errors is the lack of standardization of the transfer of essential patient information during perioperative handoffs. Some anesthesia providers will offer a thorough report that includes the patient's name, allergies, past medical history, surgical procedure, perioperative medications given, fluid status, and anticipatory guidance, whereas others may point to the record and mention 1 or 2 items only. Lastly, anesthetists must recognize the complexity of perioperative handoffs. Petrovic et al[3] emphasized that perioperative handoffs are multidimensional, involving the exchange of information and the transfer of technology, such as monitors, ventilators, transducers, and invasive lines for patients who are at higher risk for instability during this phase of care.

As stated previously, the Joint Commission reports that communication failures account for the majority of sentinel events.[1] In fact, in an effort to close this gap in communication errors, the Joint Commission now requires hospitals to standardize handoff communications.[1] In a study conducted by Jayaswal et al,[2] 84% of anesthesia providers reported receiving a poor or incomplete handoff in the previous year; 57% reported giving an inadequate report in the previous year; and 25% of anesthesia providers attributed an adverse outcome to a poor handoff. Hudson et al[4] revealed that "handover of anesthetic care during cardiac surgery is associated with a 43% greater risk of in-hospital mortality and 27% greater risk of major morbidity." Mandating the use of a handoff tool that standardizes the patient information exchanged during transfers may be the key to preventing transfer-of-care events. For example, after standardizing patient handoff processes from surgery to intensive care, Catchpole et al[5] reduced the number of technical errors, the number of information omissions, and the duration of the handoff.

In a retrospective study by Wright et al,[6] anesthetic adverse events occurred 3 times more frequently after 3:00 PM. These adverse events included improper dosing of anesthetic agents, difficulty intubating, prolonged sedation, wound infection, postoperative nausea and vomiting, pain management issues, and blood pressure changes. Echoing this "afternoon effect," Scott et al[7] discovered that the risk of error doubled when nurses worked greater than 12.5 consecutive hours. In an interview, Dr. M. C. Wright of the Department of Anesthesia at Duke University Medical Center maintained that performance suffers after hours of working and stated, "handoffs and transition care might be improved by using shared displays, similar to computerized white boards, that provide data from different sources and are available for exiting and incoming staff to view at all times."[8]

Standardizing the information exchanged during the handoff process is the key to preventing adverse patient outcomes. The Joint Commission guidelines for the handoff process recommend incorporating "interactive communications, up-to-date and accurate information, limited interruptions, a process for verification, and an opportunity to review any relevant historical data."[9] Some authors have standardized handoffs by using acronym tools on the premise that a checklist is easy to remember if it has an associated catch phrase, such as Situation-Background-Assessment-Recommendation, or SBAR, a communication tool widely used in nursing and hospital systems.[9] Wright[10] developed an anesthesia communication tool that uses the acronym PATIENT. Each letter in *PATIENT* represents 1 to 4 components of a typical anesthesia report; for example, the *P* represents procedure, patient, and position. To date, this is the only anesthesia-specific handoff tool noted in the literature.

Electronic health care records have gained popularity in the last decade, and anesthesia departments are utilizing electronic anesthesia records with increasing frequency. Bosman[11] concluded that incorporating protocols, hospital policies, and industry or department guidelines in the computerized information system will optimize workflow. Computerized information systems improve patient safety by reducing errors in knowledge and ensuring that patient information and online databases are available at the provider's fingertips.[11] When one web-based computerized sign out system was trialed by residents, the tool reduced the number of patients missed on rounds, improved the quality of sign outs, and reduced the workload by 3 hours per week.[12]

Few studies have been conducted to evaluate electronic anesthesia handoff tools. Jayaswal et al[2] conducted a pilot study of a mandatory electronic handoff tool contained in the electronic anesthesia record. The focus of the study by Jayaswal et al[2] was consumer satisfaction with current patient handoff practice and the development of an electronic handoff tool; a follow-up survey regarding satisfaction with the tool is pending. Despite overwhelming evidence of inadequate patient transfers between anesthesia providers causing patient harm, no published studies are available regarding the effect of a standardized electronic patient care transfer tool on patient safety.

Despite advances in technology, human errors in medicine continue to occur with impressive frequency. Furthermore, adverse anesthesia events occur more often after 3:00 PM. Inadequate exchange of patient information during transfer of care significantly increases the risk for patient harm. Perioperative handoffs require transfer of patient information, surgical information, medication information including response to medications, technology information, and anticipatory guidance.[3] The development of a provider-friendly electronic handoff tool contained within the electronic anesthesia record has the potential to decrease errors and omissions during the exchange of information, thereby enhancing patient safety. The emphasis of this study was to compare the incidence of patient information inaccuracies and omissions during patient care transfer before and after implementation of an electronic patient care transfer tool. Omissions during patient care transfer were also assessed in relation to the time of day and to American Society of Anesthesiologists (ASA) physical status classification.

MATERIALS AND METHODS

This study was conducted by use of a preintervention/postintervention observational design. The researcher observed the transfer of patient care by one group of certified registered nurse anesthetists (CRNAs) before and after implementation of the intervention. Before the intervention, the researcher collected data during intraoperative patient care transfers, recording any omissions and inaccuracies in the report on a 13-item checklist. The researcher also recorded time of day, phase of case, number of providers, patient's ASA status, and duration of report. All observations of patient care transfer during an anesthetic were included. Exclusionary criteria were patient care transfers completed by student nurse anesthetists and newly hired nurse anesthetists undergoing orientation. Additional exclusions were made if patient care transfer communication was interrupted by patient care needs. Each observation of patient care transfer information was recorded in written format to avoid any omissions by the investigator. The information was then transferred to the data collection tool. Per usual practice, the patient's electronic heath record was accessed to obtain the information required for patient care during the break or relief of the intraoperative case.

After 82 patient care transfers were observed, the intervention was implemented by educating the staff CRNAs on the importance of appropriate patient handoff and the use of the tool. All CRNAs in the anesthesia practice were educated on the use of the handoff tool by a third party. The majority of the CRNAs were introduced to the tool at a staff meeting, where the chief CRNA provided education on the use and benefit of the electronic patient care transfer tool. Any CRNAs not present at the staff meeting were provided individual education. After a 2-week period during which the staff CRNAs were allowed to acclimate to using the electronic handoff tool, 75 postintervention intraoperative patient care transfers were observed and recorded. The before and after observations were then compared to measure reductions in omissions and inaccuracies after implementation of the tool.

Demographic data on the CRNAs were collected via questionnaire after all observations were completed and included the participants' gender, age, education, and years of practice (**Table 1**). The data were entered into a password-protected database, and the questionnaires were stored in a locked cabinet.

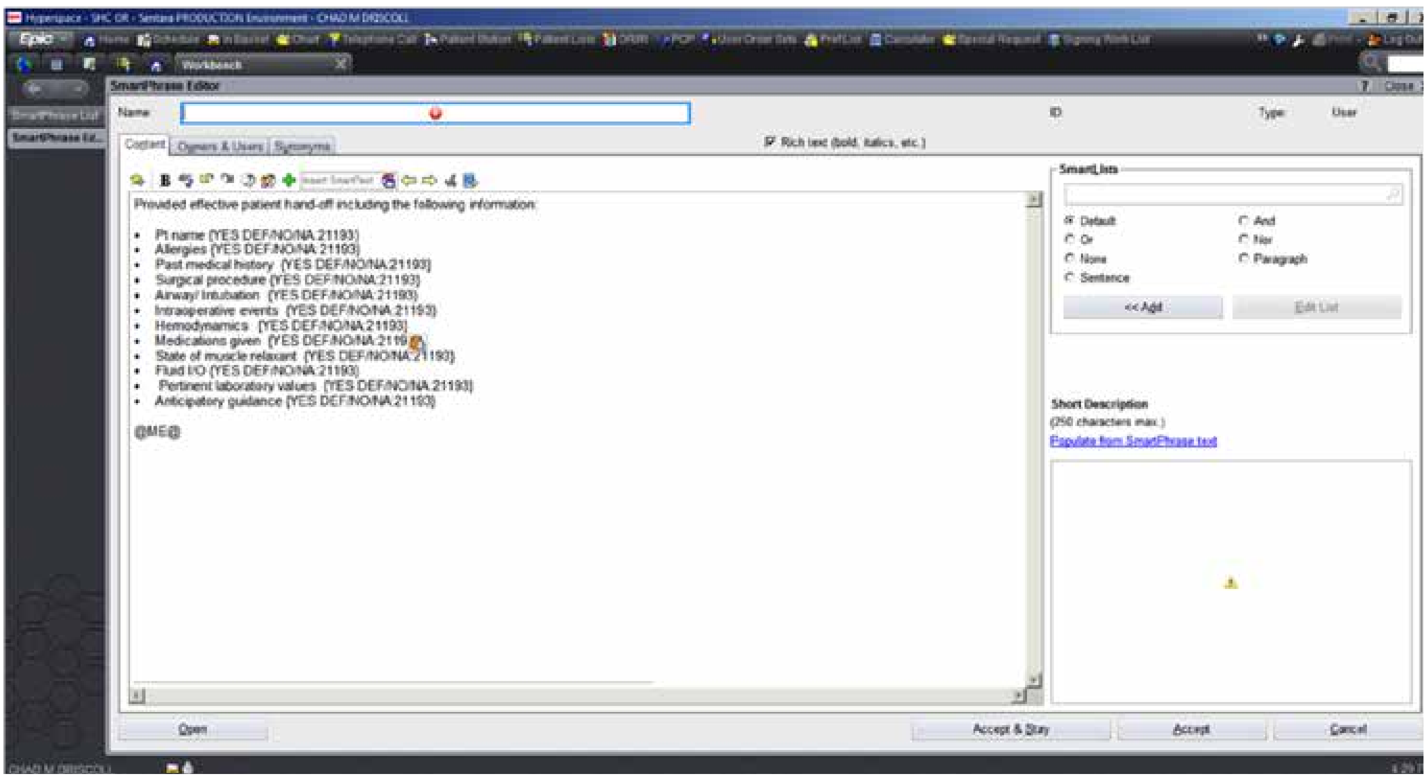
Table 1. Demographic Data of the Participants

Demographics	**Staff CRNAs (n=10)**	
	No.	**%**
Gender		
Male	3	30%
Female	7	70%
Age		
25-34 years	2	10%
35-44 years	3	30%
45-54 years	3	30%
55-64 years	3	30%
Education		
Diploma degree	0	
Bachelor's degree	3	30%
Master's degree	7	70%
CRNA Experience		
1-4 years	0	
5-9 years	3	30%
10-14 years	4	40%
15-19 years	0	
20-24 years	0	
25-29 years	0	
30-34 years	2	10%
35-39 years	2	20%

The study site was Sentara Careplex Hospital in Hampton, Virginia. A total of 16 full- and part-time CRNAs practice at Sentara Careplex Hospital. The practice employs male and female CRNAs with a variety of educational backgrounds, years of experience, and a wide age range. Targeted participants for the study were male and female CRNAs aged 25 to 70 years. The CRNAs practicing at Sentara Careplex Hospital were automatically enrolled in the study. The principal investigator was studying routine practice habits; therefore, informed consent was waived. This study used a within-subjects design; there was no randomization or control group.

The electronic patient care transfer tool provided a formal structure for intraoperative patient handoff. The information recorded included details of patient name, allergies, health history, surgical procedure, airway/intubation, intraoperative events, hemodynamic status, medications, state of neuromuscular blockade, fluid status, pertinent laboratory values, and anticipatory guidance (**Figure 1**).

Figure 1. Electronic Patient Care Transfer Tool



Statistical Analysis

Data were analyzed by using SPSS 20 software (IBM Corp, Armonk, NY) . Demographic data related to sex were analyzed by using a chi-square test. Interval demographic data related to age, years of practice, and educational level were analyzed by using descriptive statistics.

A power analysis was performed for two-tailed analysis with alpha at $P < 0.05$, estimating an effect size at 0.7. Independent two-tailed t-tests were used to evaluate the differences in omissions and inaccuracies of patient data during perioperative handoffs before and after implementation of the electronic patient care transfer tool.

Twelve patient care information items were identified as essential components of patient care handoff. Data were then assigned to the following ordinal categories: 0=no omissions, 1=partial omission, and 2=full omission. Omissions in all 12 categories were compared by using independent two-tailed t-tests with Levene's test for equality of variances (equal variances were not assumed).

Independent two-tailed t-tests with Levene's test for equality of variances (equal variances were not assumed) were used to analyze if there was a significant difference in perioperative handoffs provided before and after 3 PM related to omissions and inaccuracies of patient data. The Spearman rank-order correlation coefficient was used to analyze the difference in the number of inaccuracies and omissions of patient data during patient care transfer based on ASA physical status classification.

RESULTS AND DISCUSSION

The demographic data of the CRNA participants are shown in Table 1. Three CRNA participants were male and 7 were female. The average age of the sample group was 48.3 years (SD: 10.8), with a range from 30 to 63 years. The average length of CRNA experience was 17.3 years (SD: 12.48). Thirty percent of the CRNAs described their highest level of education as a bachelor's degree (n=3), and 70% (n=7) reported holding a master's degree.

Observations of 157 handoffs were conducted: 52% (n=82) before the introduction of the electronic patient care transfer tool, and 48% (n=75) after the introduction of the electronic patient care transfer tool. Omissions were significantly reduced in all of the following patient information categories after the introduction of the electronic anesthesia patient care transfer tool: patient name, allergies, past medical history, surgical procedure, airway/intubation, intraoperative events, hemodynamic status, medications given, state of neuromuscular blockade, and fluid status (P = 0.000); pertinent laboratory values (P = 0.001); and anticipatory guidance (P = 0.005) (**Figure 2** and **Table 2**). The

Figure 2. Omissions During Patient Care Transfer Before and After Implementation of an Electronic Patient Care Transfer Tool. Abbreviations: I/O, fluid status; PMH, past medical history; NMB, state of neuromuscular blockade.

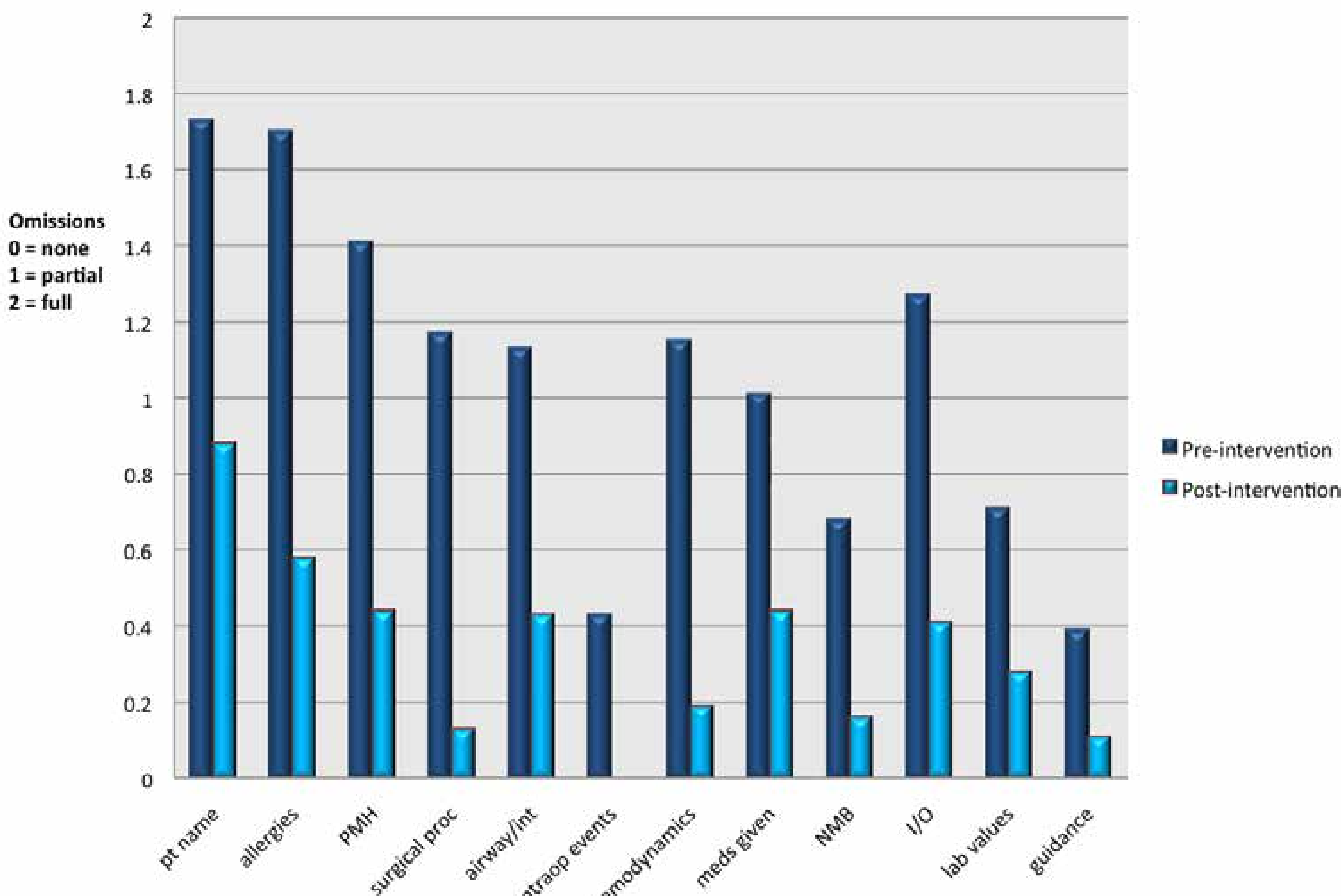


Table 2. Omissions During Patient Care Transfer Before and After Implementation of an Electronic Patient Care Transfer Tool

Variable	Preintervention Mean (SD)	Postintervention Mean (SD)	t	P
Patient name	1.73 (0.69)	0.88 (0.99)	6.17	0.000
Allergies	1.70 (0.71)	0.58 (0.90)	8.48	0.000
Past medical history	1.41 (0.68)	0.44 (0.68)	8.93	0.000
Surgical procedure	1.17 (0.99)	0.13 (0.50)	8.37	0.000
Airway/intubation	1.13 (0.99)	0.43 (0.82)	4.88	0.000
Intraoperative events	0.43 (0.82)	0.00 (0.00)	4.73	0.000
Hemodynamic status	1.15 (0.98)	0.19 (0.59)	7.50	0.000
Medications given	1.01 (0.71)	0.44 (0.60)	5.50	0.000
State of NMB	0.68 (0.95)	0.16 (0.55)	4.30	0.000
Fluid status (I/O)	1.27 (0.93)	0.41 (0.79)	6.22	0.000
Pertinent laboratory values	0.71 (0.95)	0.28 (0.69)	3.25	0.001
Anticipatory guidance	0.39 (0.77)	0.11 (0.45)	2.85	0.005
Total handoff items	12.78 (5.10)	4.05 (3.87)	12.14	0.000

Note. Abbreviation: NMB, neuromuscular blockade.

mean total number of omissions before the intervention was 12.78 (SD: 5.10), and the mean total number of omissions after the intervention was 4.05 (SD: 3.87). The difference in patient information omissions between the preintervention group and the postintervention group was significant ($t = 12.14$, $P = 0.000$). Only 5 inaccuracies were noted during the observations: wrong allergy, wrong procedure, wrong medication dose, wrong laboratory value, and wrong ventilator mode setting. All 5 inaccuracies were observed in the preintervention group.

Of the 157 patient care transfers observed, 73% (n=115) were conducted before 3:00 PM and 27% (n=42) were conducted after 3:00 PM. Of the 82 preintervention observations, 74% (n=61) were made before 3:00 PM and 26% (n=21) were made after 3:00 PM. Of the 75 postintervention observations, 72% (n=54) were made before 3:00 PM and 28% (n=21) were made after 3:00 PM. There were trends toward more omissions after 3:00 PM in 11 of the 12 handoff categories in the preintervention phase; however, only one category (anticipatory guidance) was statistically significant ($P = 0.05$; **Table 3**). In the postintervention phase, only 5 of the 12 handoff item categories had more omissions after 3:00 PM, with anticipatory guidance remaining the only statistically significant category ($P = 0.04$).

Thus, although the researcher predicted that patient care transfers would be more abbreviated during late afternoon hours as clinicians grew more fatigued or were anxious to leave, the difference in most patient information categories was not statistically significant. The sample size for the preintervention and postintervention groups was small (n=21). The preintervention group also had considerable numbers of omissions, with 25 omissions out of 25 possible omissions in one perioperative handoff. With the poor quality of patient care handoff observed in the preintervention group overall, there was not much prospect for omissions to increase after 3:00 PM. A larger sample size may have detected a difference.

Of the 157 patient care transfers observed, 4.5% (n=7) of the patients were classified as ASA I; 34.4% (n=54) were classified

Table 3. Omissions During Patient Care Transfer Related to Time of Day

Variable	Preintervention		Postintervention		t	P
	Mean	SD	Mean	SD		
Patient name Before 1500 After 1500	1.77 1.61	0.64 080	0.89 0.88	1.00 1.01	Pre 0.78 Post 0.12	0.44 0.90
Allergies Before 1500 After 1500	1.66 1.81	0.75 0.60	0.52 0.76	0.86 0.99	Pre -0.95 Post -0.99	0.35 0.33
Past medical history Before 1500 After 1500	1.36 1.57	0.71 0.60	0.48 0.33	0.72 0.58	Pre -1.33 Post 0.93	0.19 0.35
Surgical procedure Before 1500 After 1500	1.08 1.42	1.00 0.93	0.11 0.19	0.46 0.60	Pre -1.45 Post -0.55	0.16 0.59
Airway/intubation Before 1500 After 1500	1.09 1.23	1.00 1.00	0.44 0.38	0.84 0.80	Pre -0.56 Post 0.30	0.58 0.76
Intraoperative events Before 1500 After 1500	0.33 0.71	0.75 1.00	0.00 0.00	0.00 0.00	Pre -1.68 Post - 0.80	0.10 0.43
Hemodynamic status Before 1500 After 1500	0.98 1.29	1.00 0.96	0.15 0.29	0.53 0.72	Pre -0.77 Post -080	0.45 0.43
Medications given Before 1500 After 1500	0.97 1.14	0.68 0.79	0.43 0.48	0.60 0.60	Pre -0.91 Post -0.33	0.37 0.75
State of NMB Before 1500 After 1500	0.66 0.76	0.95 0.90	0.15 0.29	0.53 0.60	Pre -0.44 Post -0.28	0.67 078
Fluid status (I/O) Before 1500 After 1500	1.26 1.29	0.95 0.96	0.46 0.29	0.82 0.72	Pre -0.10 Post 0.92	0.92 0.36
Pertinent laboratory values Before 1500 After 1500	0.70 0.71	0.95 0.96	0.31 0.19	0.72 0.60	Pre -0.04 Post 0.76	0.97 0.45
Anticipatory guidance Before 1500 After 1500	0.28 0.71	0.69 0.90	0.15 0.00	0.53 0.00	Pre -2.02 Post 2.06	0.05 0.04
Total handoff items Before 1500 After 1500	12.26 14.29	5.10 5.05	4.09 3.95	3.43 4.90	Pre -1.58 Post 0.12	0.12 0.91

Note. Abbreviation: NMB, neuromuscular blockade.

as ASA II; 51% (n=80) were classified as ASA III; and 10.2% (n=16) were classified as ASA IV. In the preintervention phase, 5 patient care transfer items were negatively associated with ASA status: patient name, past medical history, surgical procedure, hemodynamic status, and fluid status (**Table 4)**. Two patient care transfer items were significantly correlated with ASA status: pertinent laboratory values and anticipatory guidance ($P < 0.05$). In the postintervention phase, 8 patient care transfer items were negatively associated with ASA status (patient name, allergies, surgical procedure, hemodynamic status, medications given, state of neuromuscular blockade, pertinent laboratory values, and anticipatory guidance), with no items correlating to ASA status.

Thus, there were no differences in inaccuracies and omissions related to the severity of patient comorbidities on the basis of the patients' ASA physical status classification. However, the distribution among the ASA physical status categories was not proportional; there were many more ASA II and III patients than I and IV. This distribution may have accounted for the nonsignificant findings. The negative Spearman correlation indicated that there were fewer handoff omissions in the higher ASA classes, which may suggest that practitioners caring for more critical patients provided a more thorough handoff.

In the busy operating room environment, anesthesia providers care for patients undergoing intricate surgeries. With advances in medicine, critically ill patients are living longer and frequent surgical arenas worldwide. Christian et al[13] note that "complexity is manifest in the patient and treatment protocol, as well as the high level of technology and coordination required to effectively manage rapidly changing conditions." With the added production pressure and time constraints of this setting, handoffs are often brief, rushed, or sometimes omitted altogether. These types of handoffs lead to confusion, reduce the opportunity for

Table 4. Omissions Related to American Society of Anesthesiologists Classification Status

Variable	Preintervention (n = 82) Postintervention (n= 75)		Postintervention (n= 75)	
	Correlation Coeff.	p	Correlation Coeff.	P
Patient name	-0.018	0.875	-0164	0.159
Allergies	0.173	0.120	-2.17	0.062
Past medical history	-0.085	0.448	0.056	0.635
Surgical procedure	-0031	0.779	-0.208	0.073
Airway/intubation	0.129	0.247	0.034	0.774
Intraoperative events	0.058	0607	0	0
Hemodynamic status	-0220	0.047	-0.038	0.745
Medications given	0.035	0.752	-0.233	0.044
State of NMB	0.054	0.631	-0.076	0.518
Fluid status (I/O)	-0.024	0.832	0.128	0.273
Pertinent laboratory values	0.356	0.001	-0.020	0.863
Anticipatory guidance	0.253	0.022	-0.027	0.818
Total handoff items	0.095	0.396	-0.090	0.440

Note. Abbreviation: NMB, neuromuscular blockade.

clarification, and compromise quality patient care.[14] This study confirms previous findings that communication breakdown and loss of information occur during peri-anesthesia handoffs, threatening patient safety. Utilizing an electronic anesthesia handoff tool within the electronic health record provides much needed structure to the complex communication and information flow. The results of this study were positive; however, further research is required to validate the effectiveness of the electronic patient care transfer tool in additional anesthesia settings and with a larger number of participants. This was the first study to observe perioperative handoff practices of CRNAs; additional studies investigating practice habits are needed. Research in this area would provide guidance regarding interventions that enrich best practice. Additional research regarding how electronic patient care transfer tools affect patient morbidity and mortality is required to further the CRNA impact on patient safety.

Inadequate handoffs result in a distressing number of patient injuries each year.[15,16] This is due, in part, to a need for more scrutiny of communication patterns in health care and the fact that the majority of health care professionals do not receive formal education regarding transfer of patient care.[14] The results of the present study show that standardizing transfer by use of a handoff tool contained in the electronic anesthesia record significantly reduces the number of omissions and inaccuracies during perioperative patient care transfer. In an effort to bolster patient safety, the Joint Commission required hospitals to employ standardized handoff communications over 8 years ago, yet many anesthesia departments have failed to implement any formal patient care transfer process.[1] The patient care transfer tool created and tested in the present study satisfies the Joint Commission's directive and has the potential to improve patient safety. This tool may close the gap in communication errors and prevent errors. If this tool is adopted system-wide, over 500 perioperative patient care transfers could be positively impacted each day. Furthermore, this tool would enhance patient care transfers to the post-anesthesia care unit or to the intensive care units.

Communication patterns in health care require scrutiny. The majority of health care professionals do not receive formal education regarding transfer of patient care.[14] Teamwork training is integral in many high-risk professions like aviation and the military. Further research into teamwork training with respect to the effectiveness of patient care transfer would expand the scholarship of this sizable problem.

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