

## Handoff Communication: An APSF Safety Initiative and Perioperative Provider Concern

by Steven Greenberg, MD, FCCP, FCCM

The substantial number of preventable deaths and other adverse events associated with health care are now widely recognized.<sup>1,2</sup> Handoffs (also called handovers), or transfers in care responsibilities of various types, are among the most important contributors to these outcomes that we must strive to improve. Approximately a decade ago, The Joint Commission (TJC) reported that ineffective communication was the most common reason for sentinel events among a variety of medical specialties.<sup>3</sup> Subsequently, TJC made handoff communication a national patient safety goal.<sup>3</sup> The Accreditation Council for Graduate Medical Education (ACGME) followed suit and made handoff communication education a requirement for all accredited teaching programs in the US.<sup>4</sup> The reduction in resident work hours coupled with the increase in the number and variety of alternative providers participating in patient perioperative care prompted TJC, the ACGME, and other governing bodies to urge for a rational approach to handoff practices.<sup>5</sup>



The APSF's mission is to continually improve the safety of patients during anesthesia care by enhancing research, education, and promoting programs that stimulate ideas for positive safety change. As one step toward fulfilling that mission, the APSF has provided funding to investigate the optimal manner for providing perioperative transitions of care. In addition, this year's Stoelting con-

ference, entitled "Perioperative Handoffs, Achieving Consensus on How to Get It Right," focused on developing a multidisciplinary consensus on critical elements for safe handoff processes (watch for the conference report in an upcoming issue). Throughout this issue of the *APSF Newsletter*, we highlight some key topics that point the way toward achieving a goal that no patient should be harmed as a result of a transfer of perioperative care. Dr. Jeffrey Cooper, renowned for his work in this field, convened several experts to describe the various types of handoffs, discuss the evidence for the process and elements of an optimal handoff, examine some challenges of implementation, and consider the creation of a multicenter collaborative to improve the education, research, and implementation of perioperative handoffs. We hope all readers will be motivated to reflect on their own handoff processes and behaviors and hope you and your organizations face the challenge of reducing harm from suboptimal handoff practices by getting involved to work for improvement.

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American Society of Anesthesiologists

ASA/APSF Ellison C. Pierce Jr., MD  
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Closing the Gap Between  
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Annual Meeting of the American  
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October 21, 2017**  
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## All Handoffs Are Not the Same: What Perioperative Handoffs Do We Participate in and How Are They Different?

by Amanda Lorinc, MD, and Christopher Henson, DO

### Handoffs

Handoffs, in the most concise description, are an exchange of responsibility for one or more patients from one provider to another. Handoffs are "conversations rather than reports"<sup>1</sup> and typically consist of four phases—preparation (by both parties), patient arrival in the new location, the actual handoff (e.g., RN-MD interaction), and post-handoff management by the receiving clinician.<sup>2</sup> The practice of perioperative care involves frequent transitions of patients between multiple providers and areas of care. 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. A handoff is an opportunity to review care and potentially correct mistakes; however, poor handoffs may lead to information loss and adverse patient outcomes.<sup>3-5</sup> Some of the major contributors to poor handoffs include distractions, interruptions, inadequate preparation, lack of a structured report, lack of understanding, production pressure, incomplete information exchange, and poor interpersonal interactions. The interactions between anesthesia providers and other

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APSF Newsletter

guide for authors



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# Simulation-Based Evaluation Among Board-Certified Anesthesiologists Managing Adverse Events

by Steven Greenberg, MD, FCCP, FCCM, and Matthew Weinger, MD

Objective measurement of the performance of experienced anesthesiologists during unexpected perioperative acute events is challenging. To address this issue, a national consortium recently performed a novel prospective, nonrandomized, observational study at eight simulation network group sites to quantify the technical and behavioral performances of 263 board-certified anesthesiologists.<sup>1</sup> Four scenarios (local anesthetic toxicity with hemodynamic collapse, hemorrhagic shock, malignant hyperthermia, and acute onset of atrial fibrillation with subsequent cardiac ischemia) were created for standardized delivery across study sites. Subject matter experts (who were either oral or written ABA examiners) used a Delphi process to select 72 total critical performance elements (CPEs) that were deemed essential to effective patient management in these scenarios. Anesthesiologists attending existing MOCA simulation courses volunteered to be in the study. Each of their simulation encounters was video recorded for subsequent scoring by blinded, trained raters using specific validated checklists for the CPEs as well as holistic ratings of medical/technical and behavioral/non-technical performance.

The results, in the September 2017 issue of *Anesthesiology*,<sup>1</sup> found that approximately 75% of CPEs were performed, and the majority of performances were scored as average or better on the rating scale. However, approximately 25% of all clinicians' performances were deemed as poor, often where several CPEs were missed. Overall,

the following failure modes were observed: failure to escalate therapy when initial response was ineffective, failure to discuss critical issues or raise concerns with other team members, failure to use all available resources (e.g., call for help), and failure to follow evidence-based guidelines.<sup>1</sup> Performance deficiencies were seen in both the medical/technical (e.g., treatment decisions) and behavioral/non-technical (e.g., communication, teamwork) domains. Interestingly higher-rated performances were associated with younger age but not with previous simulation experience. The presence of a second anesthesiologist improved overall performance and those who failed to call for help did less well.

As pointed out in an accompanying editorial,<sup>2</sup> in this simulation study, participants were not practicing in their familiar work environment and may not have recently experienced or reviewed the specific events manifested in the study scenarios. Therefore, caution should be used when drawing conclusions from the study. However, the findings suggest that more could be done to assure that anesthesia professionals have the most current knowledge, skills, and support to manage rare life-threatening events. Specifically, strategies to strengthen team performance during acute critical situations (such as emergency manuals or simulation) may be warranted even for experienced clinicians. Further research is required to more clearly delineate opportunities for improvement

of experienced anesthesia professionals' crisis event management and to understand how our field can strengthen every professional's lifelong learning.

*This research-based study was partially funded by the Anesthesia Patient Safety Foundation, the Agency for Healthcare Research and Quality, and by a grant from the Foundation for Anesthesia Education and Research.*

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## Perioperative Handoffs Occur in Many Different Locations

**“Perioperative Handoffs,”  
From Cover Page**

medical professionals can be a source of a significant portion of all handoffs for a patient during their hospital course. This article will discuss the main perioperative transitions of care (Figure 1) and how they differ.

**Preoperative  
Holding Room (Area) to Operating Room**

Most patients begin their operative course in a holding room, where they typically encounter pre-operative nursing, anesthesia providers, and their surgical team. The preoperative handoff thus begins in the holding room; yet little information exists on these preoperative interactions. Holding room handoffs usually involve information transfer between the patient or family

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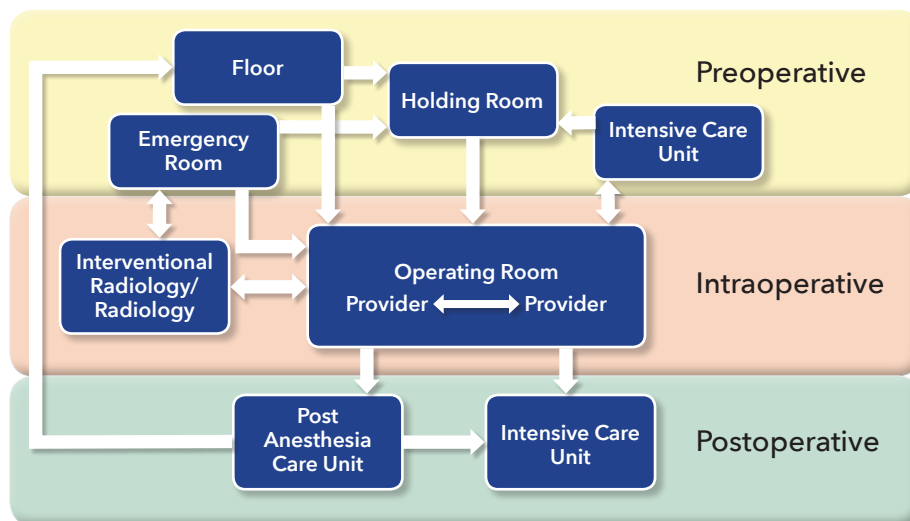


Figure 1. Perioperative Handoffs. Each arrow indicates a handoff.



# Optimal Handoffs Must Address Safety Culture Variability Among Hospital Locations and Providers

## “Perioperative Handoffs,” From Preceding Page

member, a holding room nurse, an operating room (OR) nurse, an anesthesia team member, and may or may not include a surgical team member. The quality and content of the information communicated varies significantly.

Seven percent of anesthesia-related post anesthesia care unit (PACU) closed claims were related to preoperative preparation, and communication issues were classified as a contributing factor in 14% of the 419 recovery room incidents.<sup>4</sup> The authors suggested that improvements in written, verbal, and electronic transmission of information should be addressed. A pediatric preoperative handoff study implemented a preoperative checklist that was associated with an improvement in 12 of 15 key items being discussed among providers.<sup>6</sup>

### Floor/Emergency Room/Intensive Care Unit to Operating Room

Patients do not always arrive to the OR from a holding room. They may come to the OR from any number of locations, such as the emergency department, a medical/surgical floor, or the intensive care unit (ICU), either directly or via the holding room. The variability in culture in these locations presents its own challenges and barriers, as each location may have different preparation techniques prior to OR transfer. Team composition, policies, charting, and methods of communication may differ from unit to unit. In addition, there may be limited information available due to the emergent nature of some procedures. In a study of neonatal intensive care unit (NICU) to OR handoffs, several barriers to information exchange were discovered.<sup>7</sup> These included lack of a standardized report, lack of patient preparation for transfer, unclear transition of care between team members, unclear provider roles, significant provider traffic in and out of the room, and distractions or interruptions. Not only do the providers present at the time of handoff vary widely, but up to 10 different providers were present at any given handoff. In addition, the perception of handoff quality varied widely between NICU providers (MDs, RNs, NPs) and anesthesia providers (MDs, CRNAs, RNs), with 41% reporting “fair” to “poor” and only 35% reporting “very good” to “excellent.” Caruso and colleagues suggested that standardizing ICU to OR handoffs increased communication without delaying surgery and improved anesthesia provider satisfaction scores.<sup>8</sup>

A study by Nagpal that followed 20 patients from the ward through their surgical course, found that the preprocedural teamwork phase had the largest number of failures (61.7%).<sup>9</sup> Although the anesthesia team had 86.6% of necessary preoperative information and the surgical team had 82.9% of necessary information, the nursing team only had 25% of the total information and only

27% of the total information was known by all primary team members (surgeon, anesthesia provider, surgical assistant, scrub technician, and circulating nurse). Verbal handoff from the ward to the OR team only occurred in 43% of the patients, and in 10% of the cases there was no communication between the ward nurse and the OR team receiving the patient. The study reported that information transfer failures contributed to a total of 18 incidents and adverse events in 15 of the 20 patients. In another study by Nagpal, three types of information transfer and communication failures were described in the preoperative phase: source failures (information in different places, consents missing, inadequate documentation), transmission failures (lack of communication between anesthesia and surgical teams, lack of communication between the ward and OR staff, information not relayed), and receiver failures (specialists’ opinions not followed, checklists not followed).<sup>10</sup> These failures had adverse effects on patients, teams, and the organization (such as case cancellations, increased provider stress, and wastage of resources), but these effects were not linked to any particular phase of failure.<sup>10</sup>

### Intraoperative Provider to Provider

To our knowledge, only a handful of studies exist on intraoperative handoffs. Handoffs between anesthesia providers may be for short-duty relief breaks or shift-to-shift relief. However, their presence may be associated with quantifiably increased morbidity and mortality,<sup>11</sup> and the association appears to be strengthened with each additional handoff. On the other hand, there may be a benefit associated with intraoperative handoffs, in that they may bring a fresh set of eyes to discover issues and errors.<sup>3</sup>

The intraoperative period must be considered a part of the transition from preoperative to postoperative care, and handoffs within that setting should be treated similarly. However, the intraoperative handoff is often rushed, conversational, and not well-structured. The entirety of the perioperative course may benefit from improved, structured communication,<sup>12</sup> and the intraoperative course is no exception. The quality of intraoperative handoffs has substantial variability,<sup>13</sup> depending on location, setting, and culture. Structured handoffs in a pediatric population have been shown to result in decreased communication errors and increased reliability and effectiveness of communication in the operating room.<sup>14</sup> Agarwala performed a study showing that an electronic checklist improved relay and retention of critical information at intraoperative handoff of care.<sup>15</sup>

### Location/Procedure Change

Some situations require a change in location and staff due to surgical issues or needs. For example, some institutions provide different anesthetics

for multiple procedures at multiple locations on a single infant or child to minimize the number of exposures to general anesthesia.<sup>16</sup> At other times, patients may require additional testing during an anesthetic such as interventional or radiological imaging as part of a surgical procedure. In addition, a second operative team may take part in the procedure, and their presence at the initial handoff or time-out is unlikely to be consistent.

These changes in procedure and location lead to multiple handoffs between anesthesia, surgical, nursing, and technical staff, and often require additional team members who may not have been part of the initial preoperative handoff and, therefore, will likely have limited information regarding the patient. These handoffs inevitably add complexity to the procedural care of the patient. Strategies to manage the increased complexity include adding an additional time-out when a new team assumes care of the patient, recounting instruments and supplies, and mandatory surgical site imaging post-procedure. Regardless of the strategy, providers must recognize these changes as handoffs of care.

### Postoperative Operating Room to

#### Post Anesthesia Care Unit (PACU)

Postoperative handoffs are the most common and well-studied handoffs in the field of anesthesiology. These typically involve anesthesia staff reporting to PACU nursing staff and may also involve surgical team members. In studies of routine postoperative handoffs, it was found that significant amounts of information were frequently missed, such as ASA status, antibiotics received, and fluid administration.<sup>17</sup> Handoffs of ambulatory patients also commonly resulted in omission of data and resulted in poor receiver satisfaction.<sup>18</sup> Composites of overall handoff quality are judged to be “good” less than half of the time following patient delivery to the PACU,<sup>19</sup> and the variable quality of communication of pertinent case events in most postoperative handoffs is associated with a perceived increase in complication rates.<sup>13,20</sup> As for claims data, 14% of anesthesia-related PACU issues were attributed to failures or deficiencies in communication.<sup>4</sup>

As noted above, structured handoffs in a pediatric population have been shown to significantly decrease communication errors and increase reliability and effectiveness of communication in the OR, and also in the PACU.<sup>14</sup> Nagpal also reported a decrease in information omission and task errors and an increase in staff satisfaction after institution of a standardized handoff tool.<sup>12</sup> Another study showed that a multimodal intervention substantially improved PACU handoffs, and the effect continued to be present 3 years after the intervention.<sup>21</sup> Overall, the data available supports the use of a structured approach to postoperative handoff that includes a tool and education about its use.

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# Standardized ICU Handoffs May Be Associated with Reduced Complications

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## Operating Room to Intensive Care Unit (ICU)

OR to ICU handoffs often include anesthesiology and surgical team members, OR nursing, and ICU team members, which may include physicians, nurse practitioners, physician assistants, nursing staff, respiratory therapists, and others. In some cases, the handoff from the operating room to the ICU may be the first structured handoff in a patient's hospital course, especially in emergency situations. Although many of these studies have limitations, standardized ICU handoffs may be associated with reduced long-term ICU complications.<sup>22</sup>

Improvement in the safety and quality of handoffs of patients from surgery to the ICU may occur through the adoption of the Formula 1 pit stop/aviation structured approaches.<sup>23</sup> Zoccoli *et al.* also reported the perception of improved consistency of data shared during handoffs and an increase in interdisciplinary communication by nursing staff following institution of a standardized handoff tool in the surgical intensive care unit.<sup>24</sup> Many studies have examined OR to ICU handoff processes in the cardiovascular ICU. However, it is clear that other care environments require further studies to clarify the optimal way to perform a patient handoff.

## Summary

While much of the data regarding handoffs and outcomes has been generated from postoperative and a few intraoperative exchanges, many of the barriers to effective communication exchange are universal, such as patient complexity, distractions, provider fatigue, time constraints, multi-tasking, and situational awareness/appreciation for different roles.<sup>25</sup> Additional work in this area would likely improve understanding of these deficits and improve patient safety and provider satisfaction.

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## Anesthesia Patient Safety Foundation

ANNOUNCES THE PROCEDURE FOR SUBMITTING GRANT APPLICATIONS

DEADLINE TO SUBMIT LETTERS OF INTENT (LOIs) FOR AN APSF GRANT TO BEGIN JANUARY 1, 2019 IS FEBRUARY 12, 2018

- LOIs will be accepted electronically beginning January 8, 2018 at: [apply.apsf.org](http://www.apsf.org)
- The maximum award is \$150,000 for a study conducted over a maximum of 2 years to begin January 1, 2019
- Based on the APSF's Scientific Evaluation Committee's review of these LOIs, a limited number of applicants will be invited to submit a full proposal

Instructions for submitting a Letter of Intent can be found at:

[http://www.apsf.org/grants\\_application\\_instructions.php](http://www.apsf.org/grants_application_instructions.php)

## Handoff Communication Introduction

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*He has no disclosures pertaining to this introduction.*

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# Tranexamic Acid in Obstetric Hemorrhage

by Barbara M. Scavone, MD, and John T. Sullivan, MD

## Postpartum Hemorrhage

Postpartum hemorrhage complicates approximately 3% of U.S. deliveries and is most often due to uterine atony.<sup>1</sup> Hemorrhage is the leading cause of severe maternal morbidity and contributes to 11.4% of U.S. maternal deaths.<sup>2,3</sup> Globally, it is the leading cause of maternal death.<sup>4</sup> Postpartum hemorrhage is often accompanied by a coagulopathy that may be consumptive in nature,<sup>5,6</sup> and experts therefore recommend early monitoring and replacement of factors, particularly fibrinogen.<sup>7</sup> More recent evidence suggests fibrinolysis may also play a role.<sup>7,8</sup> Bleeding patients demonstrate increases in D-dimer and plasmin-antiplasmin complexes, both byproducts of fibrinolysis, compared to non-bleeding patients, and these increases are attenuated by treatment with tranexamic acid (TXA, Figure 1).<sup>8</sup>

## Tranexamic Acid

### History and Non-Obstetric Use

TXA—trans-4-aminoethyl cyclohexanecarboxylic acid—is a synthetic lysine analog. It binds to plasminogen, blocking activation to plasmin, the leading accelerator of fibrinolysis and fibrinogenolysis.<sup>9</sup> Tranexamic acid was developed in 1962 by Utako Okamoto, a Japanese scientist, in her pursuit of a pharmacologic treatment for postpartum hemorrhage.<sup>10</sup>

Many researchers have investigated the effect of TXA on surgical bleeding. A systematic review and meta-analysis that included 10,488 patients from 129 trials demonstrated decreased risk of transfusion and possible decreased mortality among patients who received TXA versus placebo.<sup>11</sup> The findings held true across many types of procedures, including cardiac, orthopedic, hepatic, urological, vascular, and cranial surgeries. There were no differences between groups in the occurrence of in thromboembolic events, including deep venous thrombosis and pulmonary embolism.

The CRASH-2 trial investigators randomized over 20,000 trauma victims to receive TXA (1 gm over 10 minutes, then 1 gm infusion over 8 hours) versus placebo.<sup>12</sup> Those who received TXA had decreased overall mortality and decreased mortality due to bleeding, particularly notable when TXA was administered within 3 hours of injury. Subjects had no differences in thromboembolic events or deaths due to other causes.

Findings such as these led the American Society of Anesthesiologists Task Force on Blood Management to recommend consideration of prophylactic antifibrinolytic therapy during cardiac bypass, joint replacement, and liver surgeries and other clinical circumstances at high risk for excessive bleeding, and therapeutic use whenever fibrinolysis is documented or suspected; however, the task force noted that the safety of

antifibrinolytics in hypercoagulable patients, such as parturients, had not been established.<sup>13</sup>

### Obstetric Use

Prior to 2017, the literature provided little guidance regarding antifibrinolytic therapy during obstetric hemorrhage. A meta-analysis, which considered only high-quality studies, demonstrated a small (140 mL) decrease in estimated blood loss among postpartum patients who received prophylactic TXA versus placebo.<sup>14</sup> Effects on transfusion were unclear. TXA did not increase the incidence of thromboembolic events, but the analysis was underpowered to detect this event, and concerns remained because of the hypercoagulable nature of pregnancy. Furthermore, all trials had been conducted on low-risk patients undergoing cesarean section, and so the expected response in hemorrhaging patients remained unknown.

### The WOMAN Trial

Earlier this year, investigators published the results of the World Maternal Antifibrinolytic (WOMAN) trial.<sup>15</sup> This was a randomized, placebo-controlled, double-blind study involving 20,060 women diagnosed with postpartum hemorrhage from 193 hospitals in 21 countries. Patients received TXA (1 gm over 10 minutes) versus placebo; TXA was repeated if bleeding continued at 30 minutes, or if previously controlled bleeding resumed anytime during the first 24 hours. The primary outcome variable was a composite of death or hysterectomy within 42 days. Secondary outcomes included death, death by cause, thromboembolic events, obstetric interventions, and other adverse events (e.g., renal failure, sepsis, etc.). Those subjects who received TXA had decreased death from bleeding (1.5% versus 1.9%, RR 0.81 (0.65–1.00),  $P=0.045$ ) and no difference in deaths due to other causes, including pulmonary embolism, or in overall mortality, compared to control subjects. No differences existed between groups in venous or arterial thromboembolic events, or any other adverse outcomes. The difference in mortality from bleeding was most significant when TXA was administered within 3 hours of delivery.

The trial had some weaknesses. During the study, the investigators noted that enrollment often occurred concurrently with the decision to



Figure 1. Tranexamic Acid.

perform hysterectomy, and so they recalculated the sample size analysis based on death from bleeding, rather than the composite outcome; consequently the planned sample size was increased from 15,000 to 20,000. It is important to note that “These changes were made before un-blinding and without any knowledge of the trial results,” and therefore likely introduced little bias.

The authors concluded that TXA administration during postpartum hemorrhage decreases death from bleeding without increasing adverse events or death from other causes. However, the majority of subjects came from Central Africa and South Asia, and extrapolation of these results derived mostly from low- and middle-resource settings to high-resource settings may prove problematic. Over 7% of those who died in the WOMAN trial were not transfused at all. Hemorrhage-control interventions that are common in the U.S., such as uterine tamponade and brace sutures, were employed in only a small minority of cases in the WOMAN trial (7.1% and 2.7% respectively). Furthermore, the case fatality ratio of >2% in the WOMAN trial greatly exceeds that seen in the U.S. (<0.1%).<sup>a</sup> It therefore seems unlikely TXA will demonstrate an

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<sup>a</sup> US case fatality per postpartum hemorrhage can be roughly estimated by calculating the fraction:

$$\frac{(16.0 \text{ deaths}/100,000 \text{ live births})(11.4\% \text{ hemorrhage deaths}/100,000 \text{ live births})}{(3000 \text{ postpartum hemorrhage}/100,000 \text{ delivery hospitalizations})} = 0.06\%$$

where the numerator is based on data by Creanga<sup>3</sup> and the denominator, on data by Bateman.<sup>1</sup> The numerator includes all hemorrhage deaths rather than postpartum hemorrhage deaths and so this ratio may overestimate the true postpartum hemorrhage fatality ratio. The numerator computes proportion per live births whereas the denominator computes proportion per delivery hospitalizations; since there are more live births than delivery hospitalizations, this factor would also tend to overestimate the true postpartum hemorrhage fatality ratio. It seems reasonable to presume the postpartum hemorrhage case fatality ratio is < 0.06%, or a conservative estimate would be < 0.1%.

# Experts Warn Providers About Potential Side Effects and Accidental Fatal Intrathecal Delivery of TXA

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appreciable benefit to U.S. hemorrhage-related mortality. TXA does, however, decrease blood loss,<sup>14</sup> and is potentially transfusion-sparing and hysterectomy-sparing. Furthermore, the absence of excess thrombotic events in the WOMAN trial should provide practitioners reassurance regarding its safety in parturients. It therefore is reasonable to recommend TXA administration during severe postpartum hemorrhage or when severe hemorrhage is expected. No consensus yet exists regarding exactly when to administer TXA within a hemorrhage protocol, or what hemorrhage risk justifies prophylactic administration. The Maternal Fetal Medicine University Network is currently enrolling patients in a randomized controlled trial of prophylactic TXA versus placebo in the setting of known placental invasion with the primary outcome of estimated blood loss.<sup>16</sup> It is important to note that TXA serves only as an adjuvant to comprehensive hemorrhage protocols detailing timely and appropriate medical and surgical interventions.<sup>17</sup>

## Adverse Effects

Several adverse events have resulted from TXA administration. Foremost, **accidental neuraxial administration has resulted in uncontrolled seizures and death.**<sup>18</sup> Tragic lethal intrathecal administrations have been reported,<sup>18-20</sup> and clinicians should work closely with their pharmacy departments to minimize the risk of drug-swap errors (Figure 2 : Look-alike vials of TXA and bupivacaine).<sup>20</sup>

Next, although the WOMAN trial was reassuring regarding pulmonary embolism, serious thrombotic events have been reported in parturients. Renal cortical thrombosis and necrosis resulted when several obstetric patients received TXA bolus doses 1–4 gm followed by infusions 0.5–1.0 gm/hr resulting in cumulative doses of 2–11 (5.3 ± 2.8) gm (mean and standard deviation).<sup>21</sup> When TXA prophylaxis was employed in the presence of intra-arterial balloons in a patient undergoing placenta percreta surgery, aortoiliac thrombosis developed.<sup>22</sup> Similar to the cases of renal necrosis, the patient had received a loading dose of 1 gm over 10 minutes followed by continuous infusion for 8 hours. Clinicians should likely avoid TXA infusions, and TXA administration in non-flow states.

Lastly, TXA is a competitive antagonist of gamma-aminobutyric acid, which results in neuronal excitability, and dose-dependent seizures may occur after TXA administration. Experts recommend using the lowest effective dose of TXA and treating seizures that do occur with propofol.<sup>23</sup> In the WOMAN trial, seizure occurred rarely

(<1%) and at similar rates among those that received TXA versus placebo.<sup>15</sup> It is likely that most of these seizures represented eclampsia.

## Conclusions

Results of a recent large-scale clinical trial support the use and safety of TXA for obstetric patients experiencing or expected to experience severe hemorrhage. Great care must be taken to avoid accidental neuraxial administration of the drug given the lethal result. Large doses and continuous infusions should be avoided to minimize thromboembolic complications and seizure activity.

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Figure 2. TXA is available in a variety of doses, vials, and ampules and can resemble bupivacaine for intrathecal use. Therefore, caution should be used when drawing up and administering TXA or bupivacaine. Photo from Veisi F, Salimi B, Mohseni G, et al. APSF Newsletter Spring 2010;25:9. [https://www.apsf.org/newsletters/html/2010/spring/02\\_inject.htm](https://www.apsf.org/newsletters/html/2010/spring/02_inject.htm)

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# The Evidence Base for Optimal Conduct of Handoffs

by Aalok Agarwala, MD, MBA, and Meghan Lane-Fall, MD, MSHP

We submit that the preponderance of published literature suggests that perioperative handoffs are associated with patient harm, and that this harm may be mitigated by handoff standardization. However, many questions remain about the optimal conduct of perioperative handoffs. In this article, we describe evidence for the associations between handoffs and outcomes and the limited available evidence for what handoff practices are best for avoiding harm.

## All Handoffs Are Not The Same

Perioperative handoffs are heterogeneous in settings, participants, and objectives. One way to categorize perioperative handoffs is by *where and when* they occur, e.g., preoperatively from floor-to-operating room (OR) or intensive care unit (ICU)-to-OR, and postoperatively from OR-to-ICU (see article by Dr. Lorinc in this issue). Another approach, proposed by Lane-Fall and colleagues, is a three-part taxonomy of handoffs based upon the

type of transfer of care: (1) shift changes, in which interchangeable clinicians exchange places (as in an intraoperative handoff between in-room anesthesia professionals), (2) duty relief, in which one clinician is relieved for a short time with the expectation of return (as with a meal break), and (3) transitions in care, during which a patient's care is transferred from one team to another, and in which the patient may be moved from one site of care to another (as with OR-to-post-anesthesia care unit (PACU) or OR-to-ICU handoffs).<sup>1</sup>

These three handoff types are variably represented in the published literature; transition articles outnumber shift change articles, which outnumber those addressing duty relief. A 2012 review offers an in-depth treatment of anesthesia handoffs.<sup>2</sup> Here, we describe the evidence linking handoffs to patient outcomes, organized by the type of care transfer.

**Shift change.** Cooper and colleagues, more than 30 years ago, were the first to identify intraoperative handoffs as a patient safety concern.<sup>3-5</sup> They found that handoffs could be an element in causing harm, but equally, if not more importantly, handoffs presented an opportunity: a fresh set of eyes could catch potential safety hazards, such as down-trending blood pressure or an empty vaporizer. In a later paper, Cooper suggested a checklist for conducting handoffs, but without a study of its effectiveness (Figure 1).<sup>5</sup> Very few studies were published on the topic again until the 2000s, when Arbous *et al.* found a protective effect of having no intraoperative change of anesthesiologist in a retrospective case-control study.<sup>6</sup> In the past few years, four retrospective single-center database studies have specifically investigated whether there is an association between intraoperative handoffs and patient adverse events.<sup>7-10</sup> Three of the four studies found that handoffs were associated with an increased risk of composite outcomes including mortality,<sup>7-9</sup> while a fourth found no such association.<sup>10</sup>

Few intraoperative handoff studies have included handoff interventions, and these have been primarily pre-post studies without true controls. One representative study by Agarwala *et al.* found an improvement in critical information transfer and retention with introduction of an electronic handoff checklist.<sup>11</sup> Similarly, Boat *et al.* utilized quality improvement (QI) methodology to implement an intraoperative checklist, finding improved reliability of attending anesthesiologist handoffs at a pediatric hospital.<sup>12</sup> A recent interventional cohort study by Jullia *et al.* did make use of a geographically distinct control group and found that development, training, and display of a laminated checklist for intraoperative handoffs improved the observed quality of handoffs by 43% as compared to the control group.<sup>13</sup> Though evidence does not currently exist about the impact that these interventions may have on postoperative outcomes, it appears likely that structure and standardization can at least improve the transfer of information for intraoperative handoffs.

**Duty relief.** Only two studies have examined duty relief, Cooper *et al.* in 1982<sup>4</sup> and Terekhov *et al.* in 2016.<sup>10</sup> Interestingly, both found an association between duty relief and improved patient outcomes. In the 1982 study by Cooper and colleagues of more than 1,000 critical incidents during anesthesia care, 28 of 96 total incidents associated with intraoperative relief were identified as favorable, where the introduction of the relief anesthesiologist led to the discovery of an error or other failure to provide optimal care. Only 10 incidents were identified as unfavorable, where some aspect of the relief process was identified as contributing to the



Figure 1. Cooper's suggested checklist for intraoperative handoff, as printed on the back of a clipboard.

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# The Evidence and Strategies for Conducting Handoffs

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cause of the incident.<sup>4</sup> In a subsequent paper further discussing the merits of short breaks in an era where there was debate about the appropriateness of anesthesia professional relief, Cooper concluded “relief is probably better than no relief... relief that is not conducted safely is probably worse than no relief.”<sup>5</sup> In Terekhov’s 2016 retrospective study of more than 140,000 cases at a large academic medical center, the total number of intraoperative handoffs was not found to be associated with postoperative adverse outcomes, but short breaks were associated with a 6.7% decrease in adverse outcomes.<sup>10</sup> There is at least some evidence to support the common practice of giving multiple short breaks over the course of a clinical day, whether those breaks are often provided by experienced providers with fresh eyes, or that the ability to give breaks is associated with having enough staff to assist with crises.

## Transitions in Care

Studies addressing care transitions tend to focus on one of two handoff types: postoperative handoffs from OR-to-PACU<sup>12,14</sup> or from OR-to-ICU.<sup>15-17</sup> These handoffs are similar in that they involve patient movement between sites of care, interprofessional communication, and participation of multiple care team members. In contrast to most published intraoperative handoff research, transitions studies tend to be interventional. The intervention is almost always handoff standardization of some type, specifying which clinicians should be involved and scripting communication with a checklist or template. Randomization is uncommon in these studies, perhaps owing to the difficulty in randomizing clinician behavior without contamination or spillover to other settings. To our knowledge, all the published transitions studies have shown standardization-related improvements in process outcomes such as information exchange; a handful of studies have suggested improvements in short-term patient outcomes.<sup>18,19</sup>

While there are dozens of studies now published relating to perioperative handoffs, the strength of the evidence can at best be called intermediate. Among the many limitations of the existing literature, some of the challenges include the preponderance of single-center studies, most with pre-post designs and without controls, the presence of the Hawthorne effect (i.e., the phenomenon in which behavior changes because it is being observed), and the lack of information about handoff intervention sustainability. There is limited evidence about how best to implement handoff improvement interventions. Perhaps most importantly, there is very little evidence supporting a clean link between handoff process outcomes and patient outcomes.

Nonetheless, several published papers about perioperative handoffs suggest that these handoffs

Figure 2. Common handoff strategies employed in perioperative handoffs and in other high-stakes industries, as reported by Segall et al.<sup>2</sup> and Patterson et al.<sup>20</sup>

- Receiver preparation of monitors and equipment prior to patient arrival
- Completion of urgent tasks prior to verbal handoff
- Delay of transfer of responsibility during critical activities
- Limitation of distractions and interruptions
- Presence of all relevant team members
- Use of face-to-face, two-way communication
- Use of protocols to standardize processes
- Use of structured checklists to guide complete information transfer
- Receiver routinely reviewing pertinent data prior to handoff
- Ensuring that giver has adequate knowledge about previous shift activities
- Use of supporting documentation to assist with information transfer (e.g., labs, anesthesia chart)
- Opportunity for questions and concerns
- Use of closed-loop communication with read-back of critical information
- Formal team or handoff training

are associated with patient outcomes, including adverse events, major morbidity, and mortality. While causality cannot be claimed, there are several handoff process elements and behaviors that are common across the majority of published studies showing improvement in process or patient outcomes.

## Evidence for Specific Process Elements and Behaviors

Much of the early literature on perioperative handoff interventions has focused on the pediatric cardiac population. Catchpole and colleagues described development of a comprehensive handoff protocol for pediatric cardiac patients transferred to the ICU, using lessons learned from Formula 1 pit-stop crews.<sup>16</sup> They used pre-handoff information transfer and explicitly separated equipment and technology transfer from information transfer. They also mandated a group discussion supported by a cognitive aid between the surgeon, anesthesia professional, and receiving team that included information about the surgical case, anticipated problems, and anticipated recovery plans. Technical errors fell by 42%, and information omissions fell by 49%.<sup>16</sup> Joy and colleagues described implementation of a comprehensive handoff improvement intervention using QI methodology in a pediatric cardiac ICU.<sup>15</sup> The intervention was a standardized template for oral handoff presentation, along with iterative testing of the tool, education, and training. The investigators found a 75% reduction in technical errors and a 62% reduction in critical information omissions.<sup>15</sup> Other studies in the pediatric cardiac population have used similar strategies, utilizing cognitive aids, separating equipment transfer from verbal handoff, and calling attention to the importance of the receiving team verbalizing understanding and having the opportunity to ask questions.<sup>17,18</sup> A 2012 systematic

review of the published literature identified and summarized many of the common strategies employed in various studies (Figure 2).<sup>2,20</sup>

The evidence base for intraoperative shift-change handoffs is more limited. Two different studies on intraoperative handoffs by Boat<sup>12</sup> and Agarwala<sup>11</sup> both introduced checklists using QI methodology to assist with information transfer between providers at the end of shift, with inclusion of not only patient factors, but post-op plan and disposition. The Agarwala study also included items on the checklist for specific action steps (e.g., redosing antibiotics), as well as a reminder to introduce the incoming anesthesia professional to the OR team.

## Can Anything Be Learned From Other High-Risk Industries?

The importance of the transition of responsibility from one team to another is not unique to the care of surgical patients, nor is it unique to the practice of medicine. In 2004, Patterson and colleagues used direct observation to analyze handoffs in several high-stakes industries where highly reliable information transfer is critical, including space shuttle mission control, nuclear power plants, a railroad dispatch center, and an ambulance dispatch center.<sup>20</sup> Several strategies were identified as common across multiple settings, including the use of face-to-face, two-way communication with interactive questioning, limiting of interruptions and distractions, the delay of transfer of responsibility during critical activities, the receiver routinely reviewing pertinent data prior to handoff, the giver having adequate knowledge about previous shift activities, and the unambiguous transfer of responsibility.<sup>20</sup> As a routine part of

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# Perioperative Care Transitions Associated with Changes in Patient Outcomes

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their training, air traffic controllers are taught to use closed-loop communication, with read back of critical information.

Many of these strategies have been used in the published studies on health care handoffs with good reason, as medicine is highly specialized with complex technology and potentially severe consequences for system failure, with responsibility for successful management spread amongst a team of people, as compared to a single individual. The similarities between medicine and other

high-stakes environments may explain why handoff standardization has been embraced, despite the lack of “gold standard” evidence from randomized controlled trials. Most notably, the multi-center I-PASS study demonstrated a roughly 25% decrease in preventable adverse events after introduction of a comprehensive handoff standardization program for pediatric residents.<sup>21</sup>

## A Checklist Is Not Enough

Over time, there are fewer studies that question *whether* handoffs should be standardized. Instead, studies question *how* to standardize, *how much* to standardize, and how to standardize handoffs in a way that complements clinician

workflow instead of interfering with it. Indeed, standardization is at the core of all the interventional strategies described in the literature to decrease the potential harm from perioperative shift changes and transitions in care. Standardization, however, is not synonymous with the introduction of a checklist.

Checklists address only one function of handoffs—information exchange. Successful handoff standardization interventions not only include checklists or templates, but they also create expectations of clinician involvement, and they specify

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**Table 1. Selected studies\* by type of perioperative care transition.**

Reference	Findings	Metrics/Methodology
<b>Intraoperative shift-to-shift handoffs: clinicians with similar clinical roles offer permanent relief</b>		
<b>Studies evaluating long-term patient outcomes</b>		
Saager et al. <sup>7</sup> (2014)	Intraoperative handoffs associated with increase in morbidity/mortality in dose-dependent fashion	Single-center retrospective database analysis. Composite outcome of major morbidity and mortality
Hudson et al. <sup>9</sup> (2015)	Intraoperative handoffs associated with increase in morbidity/mortality in dose-dependent fashion	Single-center retrospective database analysis. Mortality alone and composite outcome of major morbidity and mortality
Hyder et al. <sup>8</sup> (2016)	Intraoperative handoffs associated with increase in morbidity/mortality in dose-dependent fashion	Single-center retrospective analysis of colorectal surgery patients. Composite outcome of major morbidity and mortality
Terekhov et al. <sup>10</sup> (2016)	No association between intraoperative end-of-shift handoffs and morbidity/mortality. Short breaks associated with improved outcomes	Single-center retrospective database analysis. Composite outcome of major morbidity and mortality
<b>Pre-post Interventional Studies</b>		
Boat & Spaeth <sup>12</sup> (2013)	Improvement in intraoperative attending-to-attending handoff reliability from 20% to 100% with use of checklist.	Interprofessional development and implementation of checklists using quality improvement methodology
Agarwala et al. <sup>11</sup> (2015)	Improvement in critical information transfer and retention, discussion of concerns, and perception of overall quality of handoff communication	Development and implementation of AIMS-based electronic handoff checklist
Jullia et al. <sup>13</sup> (2017)	43% improvement in quality of observed handoffs	Development, training, and display of laminated checklist for intraoperative handoff
<b>Intraoperative duty relief/break: clinicians with similar clinical roles offer short-term relief (&lt; 1 hour) with the expectation that the first clinician will return</b>		
Cooper <sup>5</sup> (1989)	Short breaks associated with identification of potential areas of concern or near-misses	Analysis of >1000 critical incidents during anesthesia care
Terekhov et al. <sup>10</sup> (2016)	Short breaks associated with small (6.7%) improvement in patient outcomes	Single-center retrospective database analysis. Composite outcome of major morbidity and mortality
<b>Postoperative transition of care from operating room to post-anesthesia care unit</b>		
Boat & Spaeth <sup>12</sup> (2013)	Improvement in PACU handoff reliability from 59% to greater than 90%	Interprofessional development and implementation of checklists using quality improvement methodology
Weinger et al. <sup>14</sup> (2015)	Improvement in acceptable handoffs from 3% to 87% at three years post-initiation of improvement program	Large-scale, multimodal intervention including standardized electronic handoff form, didactic and simulation-based training, performance feedback.
<b>Postoperative transition of care from operating room to intensive care unit</b>		
Catchpole et al. <sup>16</sup> (2007)	42% reduction in technical errors, 49% reduction in information omissions	Pre-handoff information transfer, explicit separation of equipment and information transfer, use of cognitive aid
Joy et al. <sup>15</sup> (2011)	75% reduction in technical errors, 62% reduction in critical information omissions	Standardized template for oral handoff presentation, implementation including iterative testing of tool, education and training
Craig et al. <sup>17</sup> (2012)	Significant improvement in pre-patient readiness, pre-handoff readiness, information transfer, and staff perception	Implementation of structured handoff process with preadmission reports and OR information

\*The cited studies do not represent all published work on perioperative handoffs. More complete lists of references are available in two published handoff reviews.<sup>2,22</sup>



# Handoff Standardization is Not Synonymous with Use of a Checklist

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the ideal conditions for handoffs to occur. They also account for the complex nature of perioperative care, breaking up the handoff process into a series of non-overlapping steps to avoid distractions and threats to attention. In this way, clinicians are able to give their undivided attention to the handoff for a short period of time, improving the reliability of the process.

### Moving Forward

While there is evidence supporting perioperative handoff standardization, there are at least two largely unaddressed aspects of perioperative handoffs. First, we do not know which standardization strategies are most useful. Published studies to date have compared one standardized process to the lack of a process, but have not compared two or more standardization strategies to each other. Second, we know very little about the implementation strategies that are effective in adopting and adhering to standardized handoffs. Clearly, there can be no true improvement in patient outcomes, even with the best standardized process, if the process is not adopted and durably followed by the clinicians responsible for patient care. For this reason, future studies require attention to implementation strategy. Implementation strategies that might be tested include customizing standardized handoffs to local clinicians' needs, developing leadership buy-in, stakeholder engagement and involvement in intervention development, education and training, champion identification, iterative adaptation, auditing, and ideally, feedback to clinicians.

Overall, there is growing interest in handoffs amongst clinicians, QI leaders, and researchers. This attention is more than 35 years in the

making,<sup>4</sup> but is certainly in keeping with our specialty's reputation as a leader in patient safety.

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ASA/APSF Featured Session

Annual Meeting of the American  
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Sorin J. Brull, MD  
APSF Board of Directors

Assessing and Analyzing the Perceptions of Perioperative  
Professionals On Neuromuscular Blockade Monitoring and  
Residual Neuromuscular Blockade

Saturday, October 21, 2017

Boston Convention Center (Room 210C)

8:00 – 9:00 AM

# Distractions in the Anesthesia Work Environment: Impact on Patient Safety? Report of a Meeting Sponsored by the Anesthesia Patient Safety Foundation

by Maria van Pelt, PhD, CRNA, and Matthew B. Weinger, MD

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Distractions in the perioperative work environment can adversely affect vigilance, situation awareness, and the ability to respond promptly to changes in the patient's condition and pose a risk to patient safety. The Anesthesia Patient Safety Foundation (APSF) believes that the role of all types of distractions and their potential adverse effects need to be addressed through open discussion, education, research, policy, and possibly other interventions. To make progress in this area, APSF convened a conference entitled "Distractions in the Anesthesia Work Environment: Impact on Patient Safety" in Phoenix, AZ, on September 7, 2016, comoderated by the authors. Robert Stoeltig, APSF immediate past president, welcomed over 100 participants who represented anesthesia professionals, surgeons, operating room (OR) and perioperative nurses, the nuclear power and surface transportation industries, and risk management. The goals of the conference were to (1) delineate the most important types of external and self-induced distractions occurring in anesthesia professionals' different work environments, (2) identify those distractions most likely to pose patient safety risks (i.e., high-risk distractions), and (3) develop recommendations for decreasing the incidence of high-risk distractions and to reduce the risk to patient safety when distractions of all types occur.

The conference started with a series of informational presentations by diverse stakeholders with associated audience response polls, followed by panel discussions and small group breakout sessions.

## Evidence and Discussion

When considering distractions, a distinction should be made between those that are externally imposed and those that are internally motivated. External distractions, which derive from many sources, can be patient care-related (e.g., a device alarm, repositioning the patient for the surgeon) or unrelated to patient care (a nurse asking about your weekend). When an external distraction has disrupted ongoing thoughts or actions, it is an interruption. The anesthesia professional can choose to immediately react to, defer responding to, or ignore external distractions. Internal distractions, those initiated by and under the complete control of the anesthesia professional, may be patient care-related (e.g., looking up lab results on the electronic medical record) or patient care-unrelated (texting a friend about dinner plans).

There are limited data available on the role of distracted behavior causing patient harm. The

American Society of Anesthesiologists Closed Claim database reports 10 (of 5822) injury claims related to distraction in the operating room (OR).<sup>1</sup> The majority of these claims included reading printed materials, phone calls, and loud music.

The presentations addressed the different types of distractions:

### 1. Patient Care-Related

Distractions inherent in the clinical work we do can be related either to the current case or another (previous or future) patient. They are more likely to be externally created and thus often present as an interruption. David Gaba (Stanford/VA Palo Alto) suggested that such distractions were an important source of patient safety risk. For example, unpredictable breaks in care continuity can compromise prospective memory, which puts clinicians at significant risk for lapses in vigilance and missing or delayed responses to critical activities. He stressed the importance of considering "attention allocation" when evaluating the impact of interruptions and distractions. Matt Weinger (Vanderbilt/VA Tennessee Valley) noted that a prior study had shown the potential "attention consumption" of the intraoperative use of transesophageal echocardiography by primary anesthesia care professionals.<sup>2</sup> Jason Slagle (Vanderbilt) presented as yet unpublished new observational data demonstrating a combined 54% prevalence of patient care- and nonpatient care-related distractions; externally distracting patient care activities were more commonly related to nonroutine events than personal or educational distractions.

### 2. Technology

Weinger emphasized the high distraction risk from technology failure and usability problems. In several studies, technology has been a contributor to about 40% of all anesthesia non-routine events. Technology can cause distraction when it fails or is unavailable, is time-consuming to use (e.g., health information technology), is mentally absorbing to use (e.g., total energy expenditure),<sup>3</sup> or interrupts workflow (e.g., false alarms).<sup>4</sup> David Reich (Mount Sinai) described the electronic health record as a source of distraction because of increased connectivity and access to information, the misalignment of technology demands and clinical workflows, and increased time demands for often low-value data entry. Cohen underscored the excessive data entry requirements in non-OR environments, often as much as 3–4 hours of additional "documentation time," and the distractions and misin-



Matthew Weinger, MD, and Maria Van Pelt, PhD, CRNA, co-chaired the APSF Conference on Distractions In the Anesthesia Work Environment: Impact on Patient Safety.

formation that can result from workarounds for HIT-induced inefficiency, such as indiscriminate cutting and pasting of information from prior encounters.

### 3. Noise and Alarms

Many of the presenters mentioned excessive noise as a significant distraction. Joseph Schlesinger (Vanderbilt) noted the finding that 85%–99% of alarms do not require clinical intervention.<sup>5</sup> The high frequency of false alarms and clinicians' responses to address them can be a significant distraction. He also addressed the impact of unmodulated music and the lack of oversight that anesthesia professionals have in regulating play, particularly during critical periods of care. Linda Groah (Association of periOperative Registered Nurses) noted that the average noise levels in the OR (66 dB) routinely exceeded Environmental Protection Agency-recommended thresholds (45 dB) and could be even higher during some surgical procedures.<sup>6,7</sup> Schlesinger highlighted the dangers of alarm fatigue, the effort required to differentiate true from false alarms, and the safety compromising behavior of those who inappropriately adjust alarm thresholds or volumes. The absence of clinician input and standardized, evidence-based design criteria in the development of the technology user interface were noted to be common causes for these high-risk distractions.

### 4. Interpersonal Dynamics

Several speakers described how individual's disruptive behavior, failures of teamwork, and an OR culture that is not conducive to safe practice all facilitate significant distractions that adversely affect patient safety. David Birnbach (University of Miami) reinforced how a hostile work environment

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## Panelists Discuss Rising Contribution of Personal Electronic Devices (PEDs) to Distractions

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can adversely affect anesthesia professionals’ situational awareness, communication, and teamwork. The presence of hierarchical gradients has been shown to exacerbate distractions through

fear of speaking up and poor prioritization of care activities.<sup>8</sup> Lynn Reede (American Association of Nurse Anesthetists) described distraction dynamics as an interplay of personal, environmental, and team-related elements. She stressed the negative

impact on safe patient care of inattention to staff wellness, a toxic culture, or practice standards that do not address vigilance and distraction management.



Expert panelists field questions from the audience at the APSF Conference on Distractions In the Anesthesia Work Environment: Impact on Patient Safety. From Left to Right: David Gaba MD, Jason M. Slagle PhD, Neil H. Cohen MD, MPH, Matthew Weinger MD, and Kristin L. Chrouser MD, MPH.

### 5. Personal (Self-Induced) Distractions

Slagle and Groah highlighted the increasing contribution of personal electronic devices (PEDs) to distraction. PEDs have been added to ECRI’s list of Top Ten Health Technology Hazards.<sup>9</sup> Groah also noted the infection risk that PEDs pose when handled in proximity to sterile areas, as well as Health Insurance Portability and Accountability Act-related confidentiality concerns when accessing and sharing sensitive information. David Hoyt (American College of Surgeons) reinforced the PED contribution to noise and distraction, particularly when used for nonemergent and nonpatient care activities. Richard Thomas (Preferred Physicians) provided a medicolegal perspective on PEDs, noting that vigilance is a stated cornerstone of anesthesia practice and that defense-favorable verdicts were unlikely when PED use was introduced as evidence for lack of vigilance, irrespective of purpose. He stressed that PED usage data were discoverable, and that consequences of PED-related plaintiff verdicts went beyond compensatory damages, including licensing sanctions, National Practitioner Data Bank reporting, and unfavorable media coverage.

Some presenters discussed distractions affecting different roles and occurring in different environments including nonmedical domains.

#### 1. The Distracted Surgeon

Kristin Chrouser (University of Minnesota) noted the high prevalence of distractions of our surgical colleagues, ranging from 14 to 33 distractions per case.<sup>10</sup> Many of these distractions were related to lapses in teamwork and communication, equipment and instrument problems, excessive noise, and resident training. Hoyt highlighted the distractive potential of environmental noise, traffic in and out of the OR, surgical equipment, phones, alarms, and misguided music.

#### 2. Distractions Outside the OR

Neal Cohen (University of California, San Francisco) pointed out that we understand less about distractions in non-OR anesthesia environments such as interventional procedure areas and intensive care units. Distracting conditions in non-OR anesthesia locations can be accentuated by the different patient populations served, less familiar and less standardized care processes and environments, ill-defined roles and responsibilities of team members, and communication challenges inherent to these locations.

**Table 1. Attitudes About Distractions**

Statement to Which Audience Members <sup>a</sup> Responded	Agreement (/Total Responding)
Even in the absence of causal relationship, PED use that was temporally associated with an adverse event will be much more difficult to defend	100% (/91)
Fatigue and sleep deprivation impact emotional resilience and cognitive function thus increasing the risk of error and injury	98% (/87)
Minimizing the potential impact of inherent distractions to patient care is as important as addressing distractions of greater “notoriety” such as personal electronic devices (PEDs)	95% (/85)
Culture and environment in the OR are an underappreciated distraction that may impact patient safety	94% (/89)
Interpersonal dynamics are important distractions in the OR	94% (/88)
The source and implication of potential distractions on anesthesia care in non-OR settings are often different than those encountered in the traditional OR environment	93% (/91)
Workplace violence and disruptive behavior cause distractions due to concerns for personal safety as well as by creating a negative emotional and physical response	93% (/87)
It is difficult to quantify the precise effects of PED use on patient care	92% (/85)
It may be useful to incorporate recommendations from nonmedical sources when creating policies on distractions	92% (/77)
A reluctance to admit that one needs help in caring for a patient can result in life-threatening distractions in the OR	91% (/89)
Anesthesia work environment distractions must be minimized to decrease the risk of human error	87% (/77)
User interfaces are often designed without adequate understanding of clinicians’ needs during actual patient care	85% (/82)
Technology-related problems result in a high incidence of distractions during patient care	84% (/85)
Some nonpatient care activities, such as checking the monthly clinical schedule or preparing for subsequent cases, are acceptable intraoperative activities and must be allowed	83% (/86)
There is limited evidence to support conclusions regarding the impact of nonpatient care-related activities in the OR	81% (/88)
I feel comfortable proceeding with elective surgery if the anesthesia electronic medical record was experiencing downtime	69% (/90)
I am satisfied with the electronic medical record workflows as currently implemented	21% (/89)
I can “multitask” without performance decrement	13% (/76)
Music should not be played in the OR	12% (/85)

Abbreviations: OR = operating room; PED = personal electronic device.

<sup>a</sup>The 111 attendees consisted of 81 physicians, 10 nurse anesthetists, 4 PhDs, 2 anesthesia assistants, 2 nurses, 1 pharmacist, 1 lawyer, and 10 other stakeholder individuals. The attendees represented academic medical centers, private practice groups, professional societies, or associations. More detailed demographics of the participants were not available.

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## Experts and Audience Members Develop Recommendations to Reduce Distractions

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#### 3. Lessons From Other Industries

Analogies between patient care and driving were made by David Strayer (University of Utah). Sixty-six percent of the more than 31,000 US car crash fatalities each year are related to distractions that occurred within 6 seconds before the accident.<sup>11</sup> He showed that humans do not actually multitask, but rather, in 98% of individuals, the brain switches between activities even if they are on different “channels” (e.g., auditory and visual).<sup>12,13</sup> Task switching was less efficient than focused attention on a single task, and in driving studies, secondary tasks were significant distractions to successful driving.<sup>14,15</sup> Strayer shared research that texting while driving induced a very high task workload, decreasing attention for the longest time (compared, e.g., with telephone conversations) and resulting in performance decrements that were more significant than driving while drunk.<sup>16-18</sup> Bruce Hallbert (Idaho National Laboratory) showcased the nuclear power industry’s intense focus on mitigating all sources of distraction, particularly in the main control room. The nuclear power industry supports a formal national program in distraction discovery, management, and reduction. Control room operators are not allowed to have any PEDs while on-shift and instead are issued highly controlled devices that support only allowed work. He underscored the risk of becoming complacent with distraction management when there is a misperception of workplace stability and safety.

### Recommendations

Based on the presentations, small group breakout sessions, subsequent discussions, and audience polling (Tables 1 and 2), this diverse group of stakeholders put forward a broad portfolio of recommendations (Table 3). In summary, departmental and OR leaders may see the greatest return-on-investment by focusing change efforts on restricting the personal use of PEDs in the OR through policies and culture change. In parallel, there is benefit to addressing provider fatigue, workplace violence and disruptive behavior, and technology-related distractions.

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A second panel of experts discussed the effect of distractions in and outside of the operating room and in other industries. From left to right: Linda Groah MSN, RN, CNOR, Lynn Reede, CRNA, DNP, MBA, Don Arnold MD, David L. Strayer PhD, and Bruce Halbert, PhD.

**Table 2. Attitudes About Possible Interventions**

Statements About Possible Interventions	Agreement (/Total Responding)
Policy statements should include the goal of educating medical staff about distractions from personal electronic devices and their potential devastating effect on patient safety	94% (/77)
Distraction policies must balance the benefits of having access to electronic devices with the potential safety risks posed by inappropriate use	94% (/76)
Leadership support and a multidisciplinary team are essential for developing and implementing a plan that reduces distractions and the level of noise in the OR	93% (/82)
Adopt a Sterile Cockpit approach because it is most relevant to OR distractions during high-risk portions of the operation	89% (/81)
APSF should develop multidisciplinary guidance to promote more effective management of distractions	88% (/77)
Given the multifactorial nature of distractions, policies should be developed locally to allow for flexibility based on the group’s or facility’s unique circumstances	83% (/86)
National standards should be developed by professional societies to promote more effective management of distractions in the procedural and surgical environments of patient care	74% (/72)
The anesthesia professional should control the acoustic environment in the OR	48% (/88)
All facilities should provide work-only electronic devices that do not allow any nonprofessional use	40% (/82)
Personal electronic device use or reading in the OR should be forbidden	30% (/86)
Adopt a zero-tolerance policy for personal electronic device/reading in the anesthesia work environment	14% (/73)

Abbreviations: APSF = Anesthesia Patient Safety Foundation; OR = operating room.

**Table 3. Recommendations With Associated Potential Specific Interventions**

Recommendation	Potential Interventions
Eliminate unnecessary clinical distractions and modulate unavoidable distractions	Use the “Sterile Cockpit” approach during critical periods, prioritize alarms; define clearly what is not permitted on facility-provided computers
Minimize avoidable distractions	Create and uphold a well-defined, risk-stratified policy for acceptable and unacceptable use of personal electronic devices
Reduce environmental noise	Select and modulate the volume of music played in clinical environments
Address factors that can worsen the effects of distractions	Develop and promulgate best practice stress and fatigue/sleep deprivation management strategies
Apply human factors engineering to improve technologies	Distraction potential should be a factor considered in the design and implementation of all medical technology used in perioperative and procedural settings
Build a culture of safety and high reliability	Greater use of teamwork, communication, and conflict resolution training, especially via simulation-based methods
Deploy professional society guidelines and toolkits	Disseminate the materials already developed by AANA, ACS, AORN, and ASA
Develop and implement local policies and guidelines	Create local guidelines and policies informed by national guidelines and best practices
Prioritize compliance and accountability	Increase local measurement, reporting, and appropriate consequences for deviation from local distraction management
Intensify research	Conduct research on, for example, generational differences in comfort with technology or the impact of educational interventions on distraction occurrence and effect
Learn more from other industries	Multidisciplinary collaborations to facilitate research, education, and policy development

Abbreviations: AANA = American Association of Nurse Anesthetists; ACS = American College of Surgeons; AORN = Association of periOperative Registered Nurses; ASA = American Society of Anesthesiologists.





# Should Transdermal Drug Patches Containing Metal Be Removed During Procedures Using Electrocautery Because of the Risk of a Burn Injury?

## Q Dear Q&A,

I am writing to inquire regarding risks to a patient when a transdermal medication patch is left in place in the setting of electrocautery for surgery. It came up recently regarding oxybutynin because the surgeon was aware of metal particles in the patch layers, and was concerned about the risk of a burn if the patch happened to be in the path between the cautery site and the grounding pad. Despite a pretty extensive literature search, I can't find any reports of patient harm. If there is a risk, it would seem to only pertain to patches that contain metal, but that information would be on the packaging of the patch, not on the patch itself. Since some patches contain metal but it is not clear from the labeling on the patch, it might seem prudent to remove all medication patches prior to surgery involving cautery if there is, in fact, a risk of patient harm.

Thank you for considering this question.

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Neither of the authors have any conflict of interest pertaining to this article.

## A Dear Dr. Gordon:

Your question about the risk of patient injury from a transdermal drug patch during surgery raises questions about both the potential for a burn, as well as alterations in medication delivery from the patch. The absence of case reports of significant patient harm from metal-containing patches is reassuring, but does not eliminate the concern for patient injury. In addition, removing the patch creates the risk of suboptimal medication delivery unless an alternate formulation of the drug is provided. Furthermore, transdermal patches provide consistent medication delivery, resulting in stable serum concentrations, which may be difficult to re-establish in the perioperative period leaving the patient at risk for under- or over-dosage. Ultimately, the risk of removing the patch should be weighed against the risk of injury if the patch is left in place.



Transdermal nicotine patch containing metal particles.

Transdermal, drug-delivery patches are self-contained dosing devices, which deliver medication into the circulation through transdermal absorption. Each patch is composed of four layers—the backing layer, drug layer, adhesive layer, and protective/release line. Some transdermal products have aluminum and other metal elements contained in the non-adhesive backing layer. Information regarding the contents of transdermal patches can be found in the product package insert and in Lexicomp in the Warning/Precautions section. In 2009, the FDA completed a literature evaluation and product review to identify transdermal patches containing metal components with the goal of reducing the risk of burn during MRI procedures.<sup>1,2</sup> During MRI, the high-energy magnetic field and fluctuating radio-frequency can cause the metal to heat through direct absorption of energy. Metal-containing patches cannot be reliably shielded during MRI; therefore, any patch with unknown metal content should be removed. A recent publication specified which transdermal patches should be removed before an MRI procedure.<sup>3</sup> The mechanism of burn injury from a metal-containing patch during MRI is different than the possible mechanism of a burn during electrocautery use.

The best guidance on the risk of burn from a metal-containing patch due to electrocautery can be found in the guidance on patients wearing jewelry in the operating room. In this case, direct contact by a monopolar cautery device with metal jewelry would risk burning the patient by passing current

Avoid exposure of application site and surrounding area to direct external heat sources. Patients experienced fever or increase in core body temperature of 40°C (104°F) secondary to a temperature-dependent increase in fentanyl release from the patch and increased skin permeability. Transdermal patch should be applied to only intact skin. Use of a patch that has been cut, damaged, or altered in any way may result in potentially fatal overdosage. Transdermal patch may contain conducting metal (e.g., aluminum), which may cause a burn to the skin during an MRI scan; remove patch prior to MRI; reapply patch after scan is completed. Due to the potential for altered electrical conductivity, remove transdermal patch before cardioversion or defibrillation.

Figure 1: Example of Lexicomp™ warning for Fentanyl Transdermal Patch.

through the jewelry. Activation of the device in close proximity to metal jewelry could transfer heat through the metal to the skin with the potential to cause a burn. Finally, there is also a concern that the metal in the jewelry could create a current path from the patient to ground, but that is an unlikely scenario. Both the ECRI Institute and the Pennsylvania Patient Safety Authority published guidance on the risk of burn injury if a patient has jewelry on during a procedure where electrocautery is used. Both organizations were quite specific in recommending "Removal of jewelry is not necessary to avoid patient burns during electrocautery."<sup>4,5</sup> This recommendation recognizes the low risk of burn potential due to electrocautery when used properly with the correct grounding pad and holstering the active end of the device when not in use. Transdermal medication patches containing metal would present no greater risk of burn related to electrocautery than metal jewelry on the skin with a potentially lesser risk since the metal is encased by non-metal layers. Another question however is the impact of electrocautery on transdermal drug delivery.

Altered drug delivery could occur due to changes in temperature at the site or from electrical current passing through the patch. Transdermal drug delivery can be significantly affected by increases in local and systemic temperatures causing increased blood flow, vasodilation, and enhanced skin perfusion at the site of applied heat;<sup>6</sup> however, the extent of alterations in transdermal drug delivery for all transdermal patches is not well

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The APSF sometimes receives questions that are not suitable for the Dear SIRS column. This Q and A column allows the APSF to forward these questions to knowledgeable committee members or designated consultants. The information provided is for safety-related educational purposes only, and does not constitute medical or legal advice. Individual or group responses are only commentary, provided for purposes of education or discussion, and are neither statements of advice nor the opinions of the APSF. It is not the intention of the APSF to provide specific medical or legal advice or to endorse any specific views or recommendations in response to the inquiries posted. In no event shall the APSF be responsible or liable, directly or indirectly, for any damage or loss caused or alleged to be caused by or in connection with the reliance on any such information.

## Transdermal Patch Drug Delivery May Be Altered By Changes In Temperature

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known. Transdermal fentanyl delivery is known to increase when the patch site is warmed and it is recommended to either remove the patch in favor of IV dosing, or ensure that it is not in a location where it can be directly warmed by a patient warming system.<sup>7-9</sup> Some manufacturers test their products at temperatures outside of normal physiologic ranges and (if available) this information may be published in the package insert and be available in the Storage/Stability or Warnings/Precautions section in the Lexicomp™ drug monograph (Figure 1). Temperature excursion testing is not an FDA requirement and is not available for all transdermal products. Electrical current has been purposely incorporated into innovative transdermal patch designs to enhance drug delivery by iontophoresis and electroporation.<sup>10</sup> In theory, it is reasonable to conclude the electrical current used in the electrosurgery procedures could increase drug delivery, but we were unable to find any literature documenting the effects (direct or indirect) of electrosurgery electrical current on transdermal drug delivery patches.

In summary, the risk of electrical current passing through a metal-containing patch and causing a burn is quite low if the patch is located outside of the surgical site and if direct application of the cautery device to the patch is avoided. The use of electrosurgery in and of itself should not be a reason to remove the patch, especially if the patient is therapeutically controlled on the level of medication delivery. Relocating the patch outside of the surgi-

cal field may be reasonable and should eliminate the potential for interaction between electrosurgery and the patch. Although it was not part of your original question, it is worthwhile emphasizing that the risk of burn from a metal-containing patch during an MRI is very real and any patch with questionable metal content should be removed prior to entering the MRI scanner. Finally, there is potential for the drug delivery to be altered by external heating or changes in skin blood flow under the patch. The impact of temperature on the dose delivered may not be documented, so ensuring that the patch is not located under an external warming device is prudent.

Ultimately, the decision to remove the patch should be based upon the need to maintain the therapeutic benefit of the transdermal delivery system and the ability to minimize the risk of leaving it in place. If the risks outweigh the benefits and it is possible to replace the transdermal delivery with another dosing route, the patch should be removed.

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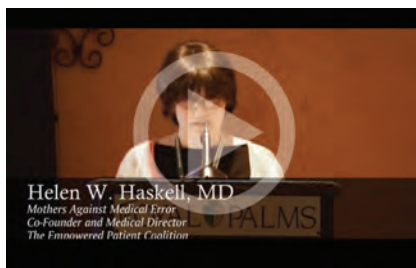
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- Perioperative Visual Loss (POVL): Risk Factors and Evolving Management Strategies (10 minutes)



- APSF Presents Simulated Informed Consent Scenarios for Patients at Risk for Perioperative Visual Loss from Ischemic Optic Neuropathy (18 minutes)

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# Multicenter Handoff Collaborative

by Philip E. Greilich, MD, FASE, and Joseph R. Keebler, PhD

Communication and team-based care are at the heart of patient safety. As anesthesia professionals, we witness this at its very best and worst when transferring patients to and from the operating room (see article by Dr. Lorinc on types of transfers in this issue). In response, we have an opportunity to take a leading role in redesigning the most ubiquitous teaming event in hospitals in a manner that promotes team-based behaviors. The impact of unreliable handoffs on communication failures and medical errors is well known. To combat this issue, mandates by The Joint Commission (TJC) in 2006 and the American Council for Graduate Medical Education (ACGME) in 2013 established requirements for creating a more structured handoff process.<sup>1,2</sup> However, like much of the quality improvement movement, progress has been slow. This isn't necessarily due to lack of tactics and technology, but appears to be related to the culture and infrastructure needed to address problems of this scope and complexity. In other words, *we need to change our approach to managing our collective efforts.*

## A New Change Model is Needed for Systemwide Adoption

The most successful work on perioperative handoffs has been limited to creating standardized processes at the unit-level (see article by Drs. Agarwala and Lane-Fall in this issue). Although considerable work remains to build an evidence base for designing efficient and effective handoffs, scaling successful pilots and demonstrating reduction in unintended events represents an even greater challenge, given the need for a supportive culture and a more sophisticated infrastructure and change model. What would an alternative approach look like? What guidance might we glean from other high-stakes industries requiring high reliability? Experts in human factors and ergonomics (HFE) and implementation science believe successful redesign and implementation efforts must adhere to some basic principles.<sup>3-6</sup> These include 1) a systemwide commitment by health care leaders and executives; 2) participation of all stakeholders; 3) multimodal, multilevel training reinforced by decision support systems (EMR, data analytics); 4) multi-source feedback (learning, behaviors, outcomes) communicated to all stakeholders; and 5) facilitative project management with subject matter experts (e.g., education, team training, human factors, quality improvement, information technology, etc.). Even though this represents a significant institutional commitment, the ability to model high reliability behaviors during this ubiquitous teaming activity

has substantial collateral benefits in promoting a culture of safety.

Nationally, our ability to translate HFE and implementation science principles to handoffs will also require a more collaborative organizational ergonomic. Our initial step is to create a culture that values sharing information and building agile teams. Specifically, current work on handoffs has been done mainly at the institutional (or unit) level, with little cross talk between organizations. There are a multitude of nationwide efforts that could help to inform and support one another. Therefore, we propose those conducting research and making policies surrounding handoffs and care transitions must begin to act as a multi-team system by forming a multicenter handoff collaborative. Inspired by the successes of the Emergency Manual Implementation Collaborative (EMIC) and others, we believe a learning collaborative built on a shared purpose and trust is the most effective way to accelerate the redesign and implementation of perioperative handoffs.

Recent groundbreaking work by Starmer *et al.* implementing the IPASS handoff bundle serves to illustrate what can be achieved with advanced design. This project demonstrated harms can be reduced when a structured handoff bundle (team training, cognitive aids, checklists, etc.) is put into place.<sup>7,8</sup> In their two-unit, single-institution pilot, teams of clinicians, educators, quality improvement specialists, medical informatics, and investigators successfully redesigned and implemented handoffs in a pediatric ward setting.<sup>7</sup> An even larger network of teams was then assembled to successfully demonstrate this could be scaled to multiple institutions.<sup>8</sup> A deeper analysis of their work illustrates some of the essential attributes that will need translating to the perioperative setting. Notable among them are special training (workshops, modules, simulation) with faculty development and feedback, tools, including the electronic medical record (EMR), and active surveillance to detect medical errors.

## Formation of the Multicenter Handover Collaborative

The Anesthesia Patient Safety Foundation (APSF) recognizes the need for a more comprehensive approach to redesigning perioperative handoffs, and in 2014 awarded Dr. Meghan Lane-Fall a grant to study "Handoffs and Transitions in Critical Care (HATTRIC)." By 2015, similar efforts were being made at several other institutions. Bound by a shared vision, yet facing similar barriers, physicians from multiple medical centers (Duke, Harvard, UPENN, UT Southwestern,

Vanderbilt) gathered at the American Society of Anesthesiology (ASA) in the Fall of 2015 and formed the Multicenter Handover Collaborative (MHC). Given his pioneering work 30 years ago in this arena, Dr. Jeffrey Cooper was asked to serve as our mentor and he graciously accepted. In the monthly teleconferences that ensued, we identified the need to create a national dialogue and consensus on foundational questions (core elements/behaviors, education, tools/training, measurement, implementation, and patient involvement) to accelerate efforts to respond to this national patient safety priority. The second national meeting of the MHC, at the 2016 ASA conference, included experts in human factors and ergonomics, education, and EMRs. During this session, we formed a MHC Steering Committee. A Scientific Program Committee was also formed in response to an invitation by the APSF to sponsor the 2017 Stoelting Consensus Conference on "Perioperative Handoffs: Getting it Right."

## Mission, Vision, Values, Objective, and Goals

The MHC intends to adopt a multi-team system approach to conducting handoff research nationwide. The MHC will act as a facilitative hub for individuals and teams testing and implementing changes in care transitions to share their strategies, successes, and failures. We hope this will create a fertile bed for innovation and collaboration for further funding, publication, and professional partnerships with the ultimate goal of improving patient outcomes. Our **vision** is that *no patient is harmed from preventable errors or information loss during the transfer of care.* Our **mission** is to *continue to build an evidence base through multicenter collaborations and teams to determine the best implementation strategies and tactics to ensure highly reliable handoffs and prevent unintended perioperative adverse events.* Our **values** include *transparency* (always speak the truth and be forthright about our motives), *engagement* (all pull our weight, no free riders), *innovation* (not afraid to try new things, don't mind failing) and *high reliability* (approaching errors as a source of learning and route to positive organizational change). We agreed that our primary **objective** would be to *create a pragmatic, sustainable, receiver-centric method for efficiently and accurately transferring information that allows clinicians to anticipate the needs of the patient and their families.* To achieve these ends, our **goals** will be the following:

1. To understand the current state of perioperative handoffs nationally by conducting a needs analysis from all stakeholders;

See "Multi-Team," Next Page



# The MHC Defines Its Goals

## “Multi-Team,” From Preceding Page

2. To publish a national consensus statement on critical elements, metrics, research questions, and strategies to guide the redesign and implementation of highly reliable perioperative handoffs;
3. To organize funded single-institution and multicenter studies (partnering with experts in human factors/ergonomics and implementation science) to compare the effectiveness of potential interventions and strategies;
4. To promote multimodal, multi-dimensional and multilevel undergraduate, graduate, and continuing medical educational and quality improvement vehicles to scale and sustain handoff redesign.

## Stakeholder and Needs Analysis

The 2017 Stoelting Consensus Conference connected members whose knowledge and influence must be leveraged to best achieve the goals outlined above. In addition to multi-specialty (anesthesia professionals, intensivists, surgeons, and nurses) and multilevel representation (students, trainees, junior and senior clinicians), we plan to include subject matter experts in the fields of human factors and ergonomics, team training, education, quality improvement, implementation science, information technology, and medical scientists. Further, our experience has taught us several additional key stakeholders must be engaged, chief among them are those with resources, such as hospital and health system executives, large practice groups and industry executives (informatics, etc.), The Joint Commission and the ACGME’s Clinical Learning Environment Review (CLER) program.

## Next Steps

The Consensus Conference’s goal was to develop a broad set of recommendations to serve as the way forward. Coordinated efforts to expand the MHC will require individuals willing to bring the energy and ideas from their respective teams to this collective effort. If needed, the MHC will develop a membership committee and chair tasked with creating platforms for linking mem-

ber-teams and sharing experiences on translating conference recommendations into clinical practice. In the coming year, the steering committee will focus on presenting the conference findings at national meetings similar to the APSF-sponsored panel at the International Anesthesia Research Society (IARS) meeting earlier this year. On behalf of the MHC Steering Committee, we look forward to learning more about your needs and ideas as we all journey to reduce harms associated with perioperative handoffs.

*Dr. Greulich is Professor and Holder of the S.T. “Buddy” Harris Distinguished Chair in Cardiac Anesthesiology, Department of Anesthesiology & Pain Management at the University of Texas Southwestern Medical Center in Dallas, TX.*

*Dr. Keebler is Assistant Professor in the Department of Human Factors at Embry Riddle Aeronautical University in Daytona Beach, FL.*

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# Low Flow and CO<sub>2</sub> Absorbents

## “Q&A,” From Page 44

### Q Dear Q&A,

Our hospital leases several GE-Datex Aespire anesthesia machines from GE and we rely on the GE service warranty with regular visits by the GE service technician for proper care of our machines. The CO<sub>2</sub> absorber that came with the machines is GE’s Medisorb which we continue to order from our GE supplier. Until now, we have not had a reason to consider changing to another CO<sub>2</sub> absorbing agent. Our only volatile anesthetic is sevoflurane. In order to reduce our sevoflurane usage we are currently laying the groundwork for establishing a very-low-fresh-gas-flow (0.3 to 1.99 L/min) protocol in our anesthesia practice. We know we would like to use a CO<sub>2</sub> absorber that is not Medisorb (75% calcium hydroxide and 3% sodium hydroxide) or similar products. We want to use an absorber with low-to-no production of Compound A and carbon monoxide under any circumstances, ideally something like Litholyme and Amsorb Plus with no reported Compound A and carbon monoxide by-products under any conditions. Much less ideally, we will reluctantly consider using other CO<sub>2</sub> absorbers such as Medisorb EF (75% calcium hydroxide and less than 1% sodium hydroxide) and SodaSorb LF if their levels of Compound A and carbon monoxide by-products are very low and are considered “safe” or “acceptable.” Since we do not own or service our anesthesia machines, I thought it would be reasonable to pose questions about the best CO<sub>2</sub> absorber for very-low-fresh-gas-flow anesthesia with our GE Aespire anesthesia machines directly to the GE reps and technical experts. I posed to our GE representative these general questions:

1. Which CO<sub>2</sub> absorbers can be used with GE Aespire machines?
2. Which of these low-flow compatible CO<sub>2</sub> absorbers could be obtained from our current GE parts and supplies vendor?

The information I received from GE included some sales material about GE’s Medisorb EF CO<sub>2</sub> absorber which contains 75% calcium hydroxide and less than 1% sodium hydroxide. The sales material stated that GE Medisorb EF (when desiccated) produced less Compound A and carbon monoxide than the regular Medisorb (75% calcium hydroxide, 3% NaOH). However, no data were presented quantifying the levels of Compound A and carbon monoxide by-products with Medisorb EF and plain Medisorb vs. other CO<sub>2</sub> absorber products. I was also provided with a July 2013 memo from a GE Director of Commercial Marketing indicating that GE anesthesia machines could only use GE-validated and GE-compatible parts and accessories, like Medisorb and Medisorb EF CO<sub>2</sub> absorbers. The memo indicated the GE service warranty is only valid if GE-validated and GE-compatible products (like Medisorb) were used with the GE anesthesia machines. The memo did not specifically state that other CO<sub>2</sub> absorber products (Litholyme, Amsorb, Amsorb Plus, etc.) were not GE-validated, -compatible, or -approved. It did not state that only GE Medisorb products could be used with a GE anesthesia machine. I was also informed that the Director of Commercial Marketing who penned the memo is no longer with GE.



Photo of an anesthesia machine flowmeter set to deliver very-low-fresh gas flow during general anesthesia.

In an effort to get a more definitive answer, I am posing these questions:

1. Which CO<sub>2</sub> absorber products are “safe” and “adequate” for very-low-fresh-gas-flow (0.3 to 1.99 L/min) general anesthesia?
2. Which CO<sub>2</sub> absorber products are “ideal” or “best suited” for very-low-fresh-gas-flow (0.3 to 1.99 L/min) general anesthesia?
3. Which CO<sub>2</sub> absorber products on the market are compatible with GE Aespire anesthesia machines?
4. Do you know of any instances where a GE anesthesia machine service warranty was voided because a non-GE or non-Medisorb CO<sub>2</sub> absorber was used?

Robert Branche, MD  
Phoenix, AZ

### A Dear Dr. Branche:

You raise interesting and timely questions as the economic and environmental impacts of inhaled anesthetics are well known, but the optimal approach to minimizing those impacts is not obvious. We will do our best to answer your questions recognizing that some of the information is incomplete.

#### 1. Which CO<sub>2</sub> absorber products are “safe” and “adequate” for very-low-fresh-gas-flow (0.3 to 1.99 L/min) general anesthesia?

The safety concern with low-flow anesthesia is the impact of anesthetic degradation by CO<sub>2</sub> absorbents leading to Compound A production in the case of sevoflurane, CO in the presence of desiccated absorbents and reduced anesthetic concentrations. It is clear from the literature that absorbents containing strong bases like potassium hydroxide (KOH) and sodium hydroxide (NaOH) are the most likely to result in anesthetic degradation, especially when dehydrated.<sup>1</sup> It is interesting to note that even Baralyme and Classic Soda Lime which contain 2.6% and 4.6% KOH, respectively, do not produce CO if they are not desiccated. In one of the original studies on this topic, published before new absorbent formulations were available, Fang *et al.* recommended using fresh gas inflow rates less than 2–3 L/min with soda lime or Baralyme to ensure that the absorbent did not desiccate and produce CO.<sup>2</sup> The trend in absorbent formulations has focused on eliminating the KOH which has been found to be the worst offender in terms of CO and Compound A production.<sup>3,4</sup>

Given this background, it is easy to recommend avoiding absorbents that contain KOH which has been eliminated from most formulations on the market. One is then left with selecting from absorbents that are either calcium hydroxide (Ca(OH)<sub>2</sub>) with or without small concentrations of NaOH added, or lithium hydroxide (LiOH). Keijzer *et al.* studied seven different absorbents, both hydrated

Table 1. A variety of CO<sub>2</sub> absorbents and the corresponding lifespan (hours)

Brand name	Distributor	NaOH content (vol%)	Amount of absorbent in canister (gram)	Canister life (hours)*	Absorbent life (hours/100 g)
Amsorb Plus	Armstrong M	0	821	10.6	1.29
LoFloSorb	Intersurgical	0	915	12.8	1.39
Medisorb EF	CareFusion	< 2.5	721	9.9	1.37
Medisorb	CareFusion	2.5	796	15.0	1.88
SpheraSorb	Intersurgical	2.5	1057	15.6	1.47
LithoLyme	Allied HC	0 **	1010	16.0	1.58
SpiraLith	Micropore	0 ***	569	18.8	3.31

\* Exhaustion defined as FICO<sub>2</sub> = 0.5%, and tested with Aisys machine, fresh gas flow 350 mL/min, CO<sub>2</sub> load 160 mL/min

\*\* LiCl as catalyst

\*\*\* Uses LiOH instead of Ca(OH)<sub>2</sub>

# Safety and Efficiency of Various CO<sub>2</sub> Absorbents

## “Q&A,” From Preceding Page

and desiccated, for the potential to produce Compound A and CO in the presence of sevoflurane.<sup>5</sup> Six of the absorbents studied were primarily calcium hydroxide although three of them also contained an extremely small amount of KOH (0.003%) and varying amounts of NaOH (1.5–3%). The seventh consisted only of LiOH. They found that CO was only produced by desiccated absorbents containing NaOH. Compound A was produced by the absorbents containing NaOH in both hydrated and desiccated forms. One of the pure Ca(OH)<sub>2</sub> absorbents produced Compound A when desiccated as did the LiOH absorbent.

Low-flow techniques have the advantage of preserving moisture in the absorbent and reducing the chance of desiccation which would reduce the concern for CO production. That said, it is possible that desiccation can occur if for example, a machine is left after emergence with a high fresh gas flow, and a more comfortable recommendation would recognize that possibility. It is easy to advocate for absorbents that do not have any KOH or NaOH, i.e., absorbents with Ca(OH)<sub>2</sub> and LiOH only, as CO production would not be a concern, desiccated or not. These absorbents would definitely be safe. Since your question focused on the use of sevoflurane, Compound A production is another concern. The data from Keijzer indicates that even absorbents without a strong base have the potential to produce Compound A when desiccated. The clinical relevance of Compound A production remains to be demonstrated and should not be a primary consideration when selecting an absorbent. Indeed, NaOH containing Ca(OH)<sub>2</sub> absorbents are routinely used outside the US during closed-circuit anesthesia without concern for, nor reports of, patient harm. Ca(OH)<sub>2</sub> and LiOH absorbents with lower concentrations of NaOH and minimal to no KOH should be both safe and adequate for use with the fresh gas flows you propose especially since desiccation is less likely at low flows since moisture is preserved.

## 2. Which CO<sub>2</sub> absorber products are “ideal” or “best suited” for very-low-fresh-gas-flow (0.3 to 1.99 L/min) general anesthesia?

This question adds another dimension to selecting the CO<sub>2</sub> absorbent. As fresh gas flows are reduced, more exhaled gas is rebreathed, more CO<sub>2</sub> must be absorbed, and CO<sub>2</sub> absorbent cost will increase. The ideal or best suited absorbent would be the lowest cost material that does not put the patient at risk from degradation of anesthetics. Evaluating the cost difference between absorbents can be complex. Factors to consider include the cost of a pre-filled canister or loose fill of a CO<sub>2</sub> absorbent canister, the intrinsic efficiency of the absorbent to absorb CO<sub>2</sub>, the total fresh gas flow, which will determine the degree of rebreathing and the CO<sub>2</sub> production of the patient(s). The intrinsic efficiency of the absorbent to absorb CO<sub>2</sub> can be determined by measuring the quantity of CO<sub>2</sub> that

can be absorbed per 100 g of absorbent material. To be meaningful, this measurement should be done by simulating clinical conditions, which will include the potential to leave some of the absorbent material unused when the canister is changed due to channeling and lack of exposure to CO<sub>2</sub>.

There are some data that shed light on the relative efficiency of different absorbent materials to absorb CO<sub>2</sub>.<sup>6</sup> In a recent in-vitro study using an AISYS anesthesia machine, Hendrickx et al. evaluated the relative ability to absorb CO<sub>2</sub> for seven different absorbent materials in pre-filled canisters. Absorbents tested included six Ca(OH)<sub>2</sub> based materials with either no NaOH or varying amounts of NaOH added, and one that is pure LiOH. (Table 1). The anesthesia ventilator was set to ventilate a simulated lung at 5 L/min with 160 ml/min of CO<sub>2</sub> supplied to the “lung” to simulate CO<sub>2</sub> production. Total fresh gas flow was set to 350 ml/min of an O<sub>2</sub> and Air mixture which would be consistent with significant rebreathing of exhaled gas in adult patients. Continuous capnography was used, and the time required to reach an FiCO<sub>2</sub> of 0.5% (3–4 mmHg) was measured.

Given the standardized testing conditions, the best information for identifying the relative efficiency of the different absorbent canisters tested is the absorbent life in hours per 100 g of material. LiOH was found to be the most efficient absorbent on a weight basis with almost double the duration of effect per 100 g of material than the next closest absorbent. Of the remaining absorbents tested, the presence of NaOH or LiCl clearly improved efficiency, with the pure Ca(OH)<sub>2</sub> absorbents showing the shortest duration per 100 g of material. The most efficient absorbent material is not, however, always the least costly. Local pricing determines the cost per absorbent canister and although LiOH was found to be the most efficient, soaring lithium prices will likely make it cost-prohibitive. Ultimately, the cost impact of utilizing more CO<sub>2</sub> absorbent at low flows will be determined by a combination of the efficiency of the material and the local pricing. Less efficient absorbent materials will need to be available at a lower cost to be as effective as the more efficient materials.

Another strategy to reduce the cost of absorbent materials at low flows is to change the material based upon the presence of inspired carbon dioxide rather than an indicator change. As the absorbent material becomes completely saturated, inspired CO<sub>2</sub> will begin to rise. The cause can easily be diagnosed by increasing fresh gas flow to exceed minute ventilation which should eliminate rebreathing and any measured inspired CO<sub>2</sub>. Picking a threshold for changing the canister based upon measured inspired CO<sub>2</sub> will ensure absorbent material is used as completely as possible before changing.

## 3. Which CO<sub>2</sub> absorber products on the market are compatible with GE Aespire anesthesia machines?

(NOTE: The APSF Committee on Technology is fortunate to have Kevin Tissot, Chief Engineer for the Anesthesia and

Respiratory Care business at GE Healthcare, as a member of the committee to respond to this question.)

GE offers a reusable absorber canister that can be bulk filled with whatever absorbent material the customer may choose. GE also offers disposable (pre-filled) canisters of absorbent material.

Using canisters that are not sold by GE does not void your warranty. However, some dimensions of the canisters are important to prevent leaks and ensure proper operation of the CO<sub>2</sub> bypass mechanism. Clearly, we test anything that we sell to make sure the dimensions are correct. We also work with other companies if we become aware of problems with their products, to encourage them to make corrections.

## 4. Do you know of any instances where a GE anesthesia machine service warranty was voided because a non-GE or non-Medisorb CO<sub>2</sub> absorber was used?

See the response above.

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Dr. Feldman serves as a member of the Clinical Advisory Board, ClearLine MD, Boston, MA. Dr. Feldman has received consulting compensation from Draeger Medical, GE Medical, and Medtronic.

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# Essential Elements for Successful Implementation of an Intraoperative Handoff Communication Tool

by Matt Kurrek, MD

## Introduction:

Most preventable adverse events in medicine are caused by communication errors and more than half of these occur in relation to care transitions. Hudson *et al.* found a 43% increase in in-hospital mortality and a 27% increase in major morbidity associated with intraoperative handoffs between anaesthetists in cardiac surgery.<sup>1</sup> Saager *et al.* and Hyder *et al.* both observed a similar effect during non-cardiac surgery.<sup>2,3</sup>

In recent years, there has been an increasing focus by The Joint Commission on improving handoffs.<sup>4</sup> This could be in part the result of a reduction in resident duty hours, resulting in increasing numbers of providers taking care of patients in any given time period<sup>5</sup> coupled with a perceived lack of education and the known risks of communication errors.

Handoff checklists are an easy way to standardize oral communication and to reduce the loss of information. Several well-designed studies



**Table 1: Considerations when creating and implementing a handoff protocol**

Opportunities	Threats
Support by administration	Lack of a local leader
Support by staff	Obstructionists
Editing to suit local needs	
Training (initial and ongoing)	
Pilot test with feedback to staff	
Regular feedback from staff to team lead	
Use in simulation centers courses	

**Table 2: Roadmap to create and implement a handoff protocol**

Roadmap	
1.	Needs assessment (audit)
2.	Discussion of results from audit with staff
3.	Getting support from leadership and administration
4.	Designating a local "leader" and members of the "focus group"
5.	Searching the literature and reviewing existing tools
6.	Creating a draft tool via modified Delphi (iterative review and edit)
7.	Adaptation to local needs
8.	Consultation with human factors expert
9.	Piloting the tool and getting stakeholder feedback

have shown their positive effect on postoperative handoffs by anesthesia professionals to PACU nurses,<sup>6-8</sup> but the intraoperative period has received much less attention.<sup>9,10</sup> We recently implemented an intraoperative communication module (consisting of a training module and a communication checklist) in the OR at a large tertiary care University Hospital<sup>11</sup> and would like to share some important lessons learned from that experience, most of which incorporate the basic steps for any change in management for new program implementation.<sup>12</sup>

## From Planning to First Draft

There are a number of considerations when creating the implementation of a handoff protocol (see Table 1). A good starting point (see Table 2) is some form of an audit (ideally by an anonymous observer—anonymous to avoid the Hawthorne effect) to assess current practice. The results of the audit could form a basis for initial discussions with staff. This process would identify documenting deficiencies, obtain support, and begin the planning process for developing a handoff tool. Support from leadership and administration is critical and will likely be a strong predictor for successful long-term implementation.

The next step in planning is to recruit a local "leader" and a small group of interested individuals who would become part of a working group to design and implement the tool in collaboration with the local stakeholders. As the project evolves (often starting with a review of the existing literature and other existing tools), a first draft is constructed. The construction may employ the Delphi method, an iterative review/edit process that will give the final product some validity. It will be

important to adapt the tool for local needs and conduct a pilot trial. This testing can be done either in a simulation center, through real-life practice sessions, or via live observations. Simulation has the advantage of allowing the testing to occur under stressful conditions (which could reveal important hidden shortcomings in the cognitive tool design). Feedback from the users will then have to be addressed. Depending on the complexity of the protocol tool and the available resources, a consultation with a human factors consultant may help to optimize the design. Outside of academic centers, this may require hiring an external consultant.

The development process will likely require several rounds of revising the draft tool in consultation with stakeholders (including administration and leadership) until a first workable version will be ready.

## Implementation

Dedicated in-service and training sessions are important steps in providing the stakeholders with the necessary tools for successful use. Even though many checklists (especially for emergencies) are intended to be intuitively easy, the lack of training can negatively impact successful use.<sup>13</sup> Several initial in-service and training sessions (as well as some ongoing refreshers) will be necessary to ensure that all staff have been trained and to reassess the full benefit of the tool. Because it may be difficult to have a control group for a comparison of tool performance after the implementation, it may be most practical to perform such an assessment using a "Before-and-After" study design.<sup>14</sup>

See "Intraoperative Tool," Next Page



# Creating a Handoff Application for Mobile Devices

“Intraoperative Tool,” From Preceding Page

## The Role of Computing Technology

The increasing use of Electronic Medical Records (EMRs) and Automated Anesthesia Information Systems (AIMS) may make it necessary to contact the local vendor via the hospital administration to explore options for integration of the handoff tool in the available EMR/AIMS (or at the very least, to ensure appropriate documentation of its use). Since several major vendors now already have their own handoff tools, the options for possible customization will have to be discussed on a case-by-case basis.

## Creation of a Handoff Application

The presentation of a cognitive aid can take on several forms (as simple as a laminated card, posted in a strategic location, an electronic version on the hospital’s intranet, or a smartphone application, etc.). Creation of an application deserves special consideration and will be discussed further. The market for mobile health care applications (app; most commonly Apple’s® iTunes Store and Google’s® Google Play) continues to expand exponentially and is changing the way health care professionals (and also patients) access and manage information. Recent estimates suggest that there may now be over 150,000 applications available with several thousand appearing every year.<sup>15</sup>

Mobile health applications, “apps,” are generally defined as a software application specifically designed for a smartphone or hand-held device that enables the app to receive and communicate health-related services or data (often with some degree of computation). Medical apps that diagnose, manage, and treat disease are regulated as medical devices and therefore are associated with a number of complex regulatory challenges that have attracted the attention of the FDA. The FDA published a statement clarifying that it intends to apply its regulatory authority only to mobile applications whose functionality could “pose a risk to a patient’s safety if the mobile app were to not function as intended.” It appears that the FDA will primarily target applications that communicate with sensors (for example an application that can obtain an ECG rhythm and diagnose atrial fibrillation, such as Kardia®) as opposed to applications that merely present information that is published elsewhere (such as ASRA Coags).<sup>16</sup>

If the application (such as the mere visual display of a common checklist) does not provide decision-making support and does not store any patient information (the latter of which could prompt concerns with the privacy of health information), then it will likely not require FDA approval as a “medical

device.” It is, however, advisable to seek input from a qualified lawyer, who would also assist in drafting the appropriate disclaimer that any user would have to accept before using the application. Since some medical malpractice carriers may not cover non-patient-related activities (such as administration and research; educational activities; creative professional activities such as publications and app development), an insurance policy against potential litigation should be considered (personal communication CMPA—Canadian Medical Protective Association, 2016). Different procedures and policies may apply to other countries. An additional strategy to limit personal liability for the developer/owner of the app may be to create a corporation that owns the app.

Writing the code for an application requires special expertise and is usually outside the scope of practice for most clinicians. It may become necessary to contract a reputable app developer to discuss the project and get an estimate for the app design, testing, and publication (and a special allowance should be calculated to allow changing of certain features as the development progresses). The cost for a simple communication tool application<sup>17</sup> is in the order of about \$15,000 (not including the cost of time of the involved clinicians). Additional costs would be incurred to cover future updates to maintain functionality with updates to the platforms’ operating systems and to keep the content of the app in sync with evolving clinical practice. The costs for more complex application will obviously increase with the time required—for example the development of the pediatric crisis checklist “Pedi Crisis” required over 2,000 person-hours of physicians, computer scientist and software engineers.<sup>18</sup>

## Summary

Handoff training and the availability of cognitive aids (posting of printed handoff checklists in each OR, computerized checklists, integration with EMR or AIMS, smartphone applications etc.) have the potential to improve the quality of communication during an intraoperative transfer of care. Education and training are a cornerstone of such a process and significant resources are required.

*Dr. Kurrek is presently Professor of Anesthesiology at the University of Toronto, Toronto, Canada.*

*Dr. Kurrek has developed ‘AnesList’ on AppStore and Google Play. He received no support and the app is downloadable for free. He derives no monetary profit from it.*

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# New Ways Explored to Promote Emergency Manual Simulation Training in China

by Jeffrey Huang, MD

Health care providers can respond to emergencies more efficiently by using operating room (OR) emergency manuals (EMs) because EMs allow rapid management with established guidelines.<sup>1</sup>

A simulation-based randomized trial demonstrated that during a series of surgical-crisis scenarios, 23% of critical actions were missed when checklists were not used vs. only 6% were missed when OR crisis checklists were used.<sup>2</sup> For those reasons, EMs are being increasingly adopted and implemented in operating rooms.<sup>1</sup>

EMs have also been adopted internationally, including in China. Three anesthesia EMs have been translated into Chinese: Stanford Operating Room Emergency Manuals, Harvard Ariadne Lab Operating Room Crisis Checklists, and Society for Pediatric Anesthesia Pediatric Critical Events Cards. The successful EMs implementation report in China was published in the *APSF Newsletter* last year.<sup>3</sup> ([http://www.apsf.org/newsletters/html/2016/Oct/06\\_ChinaManual.htm](http://www.apsf.org/newsletters/html/2016/Oct/06_ChinaManual.htm)).

Goldhaber-Fiebert and colleagues suggested in a recent study that simulation training is a powerful tool to improve clinical EM implementation and usage.<sup>1</sup> Multidisciplinary simulation training is still lacking in China. Recently, several events were organized to stimulate multidisciplinary simulation training. Emergency manuals simulation training was promoted by using a range of educational modalities including (1) lecture, (2) simulation workshop, (3) simulation demonstration in a meeting, and (4) simulation training competition.

## Workshop

An Anesthesia Crisis Resource Management Workshop was organized by the Department of Anesthesiology, Peking University People's Hospital, Beijing, China, on May 13–14, 2017 (Figure 1). The goal of this workshop was to introduce the participants to why, how, and when to use EMs and to use Emergency Manuals as a resource for both education and clinical care. The participants could become qualified teachers to organize and teach simulation in their institutes (train the trainers). Training on why, when, and how to use EMs is essential for the effective adoption and implementation of EMs in any facility.

The participants registered for a two-day simulation training session and all participants attended interactive lectures regarding the use of an emergency manual in the perioperative environment. Then they were divided into two groups. One group used a full human patient simulator (high fidelity) mannequin, SimMan Essential



Figure 1. Participants and faculty at the Anesthesia Crisis Resource Management Simulation Workshop, Peking University People's Hospital, Beijing, China.

(Laerdal, Wappingers Falls, NY, USA). The other group used CPR mannequin (low fidelity) and an iPad to display the simulated vitals generated by the SimMon (Castle Andersen ApS). The two groups were switched after two hours and each team participated in two scenarios. Each scenario lasted 15–20 minutes and was followed by a debriefing session. On Day 2, the participants were trained to write simulation training scripts. The workshop faculty included Yi Feng, Haiyan An, Hui Ju, Hong Zhang, Ran Zhang, Shuo Guan, Shuo Liu, Jie Zhang, and author Jeffrey Huang.

The workshop received very positive feedback from the participants. The survey indicated that participant satisfaction with the workshop was high. They all understood the importance of simulation training. The participants reported that they will organize simulation training in their hospitals.

## Simulation Demonstration

Training on why, when, and how to use EMs can be demonstrated by a group of anesthesia educators in an anesthesia conference. Demonstration-based methods have the advantages of simulation with lower expense. Expert demonstration appears similar to simulation and is superior to didactics for teaching incoming interns teamwork skills.<sup>4</sup> Watching a videotaped simulation case was similarly effective to participating in a simulation.<sup>4</sup> Development of demonstration-based training for teaching crisis resource management might be an effective and cost-efficient way of implementing emergency manuals.

An EM simulation demonstration was part of the program at a regional anesthesia meeting. A group of anesthesiologists from the Department of Anesthesia, Xiangyang Central Hospital, formed the "simulation education team." They created



Figure 2. The 2017 Enhanced Recovery After Surgery Perioperative Management Seminar and the Anesthesia Crisis Management Simulation Workshop was held in Xiangyang, Hubei, China.

scenarios from prior real life events. The team modified these scenarios after simulation practice to improve them for broad-based provider use.

The simulation education team rehearsed scenarios several times to ensure that no element was omitted, all required resources were available, and that it could run smoothly and realistically.

On May 6, 2017, the Enhanced Recovery After Surgery Perioperative Management Seminar and the Anesthesia Crisis Management Simulation Workshop was held in Xiangyang, Hubei, China (Figure 2). The team, led by Mingqiang Li, Fan Ye, Jianfeng Zhang, and the author, performed live in front of a large group of participants. They engaged in four OR crisis scenarios. At the end of each scenario, the experts were invited to evaluate their performance. The audience was welcome to make comments or suggestions. The simulation demonstrations were well received and highly praised by the audience.

See "Training in China," Next Page



## Emergency Manual Training Competition Successfully Launched in China

“Training in China,” From Preceding Page

### Simulation Training Competition

Multidisciplinary training in emergency manuals simulation training has been slowly implemented due to many practical issues, such as scheduling conflicts, lack of a training facility, and lack of trained instructors. Simulation competition has been demonstrated as an effective educational intervention.<sup>5</sup> In an effort to stimulate a multidisciplinary team training for emergency manuals implementation, an Operating Room Emergency Manuals Simulation Training Competition was launched as a pilot program in Zhongshan City, Guangdong, China. The competition invitation was sent to each local hospital by the Zhongshan City Society of Anesthesiology. The organizing committee was led by Binfei Li and Chunyuan Zhang. The hospital was required to send a video clip of simulation training for evaluation. The top scoring teams advanced to the final round, a half-day event where multidisciplinary teams from seven local hospitals competed against each other. The finals were judged by a panel of experts from outside Zhongshan City. Each team wrote their own simulation scenario, and rehearsed their scenario prior to the competition. Content was focused on crisis resource management skills by using cognitive aids (Stanford Operating Room Emergency Manuals).

The judges' panel was composed of three anesthesiologists (Wenqi Huang, Wuhua Ma, and the author). The scoring tool design was based on ANTS (Anesthetist Non-Technical Skills). According to total

scores of three judges, the teams were awarded 1st, 2nd, and 3rd places (Figure 3). Every team in the final round received an award. The seven hospitals in the final round included People's Hospital of Zhongshan, Hospital of Traditional Chinese Medicine of Zhongshan, Boai Hospital of Zhongshan, Zhongshan Torch Development Zone Hospital, Huangpu People's Hospital of Zhongshan, Zhongshan Dongshen Hospital, and Zhongshan Banfu Hospital (Figure 4).

To our knowledge, this competition is the first of its kind in China. The organizing committee received strong positive feedback from participants and faculty involved. The event has served as a catalyst to stimulate the participants to organize simulation training for implementation of operating room emergency manuals. Plans for the continued growth of this project are under way.

### Conclusion

Simulation workshops, simulation demonstrations in a meeting, and simulation training competitions are potential approaches to promote multidisciplinary simulation training and implementation of EMs. Successful implementation of EMs in China depends on all-level leadership support, individual provider participation, frequent EMs review, and simulation training.

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*Dr. Huang has no conflicts of interest to declare.*



Figure 3. The 1st place winners with judges (left to right: Wenqi Huang, Jeffrey Huang, Hongtao Liang, Zhou Cheng, Wuhua Ma) at the Operating Room Emergency Manuals Simulation Training Competition in Zhongshan, Guangdong, China

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Figure 4. The Operating Room Emergency Manuals Simulation Training Competition was organized in Zhongshan, Guangdong, China. The participating teams included People's Hospital of Zhongshan, Hospital of Traditional Chinese Medicine of Zhongshan, Boai Hospital of Zhongshan, Zhongshan Torch Development Zone Hospital, Huangpu People's Hospital of Zhongshan, Zhongshan Dongshen Hospital, and Zhongshan Banfu Hospital.



## Letter to the Editor:

# How Standardization Can Improve OR Efficiency, Clinical Outcomes, and Patient Safety

by Adam L. Blomberg, MD

Standardizing evidence-based best practices is a key to delivering high-value, efficient care that promotes patient satisfaction. However, that standardization should not be a one-size-fits-all approach, which can have negative implications for outcomes and safety.

### Preadmission Testing (PAT)

Traditionally, preadmission testing had tremendous variability. Surgical teams often would “test everyone for everything” to help prevent cancellations. Even today, overuse remains a patient safety issue. Providers often perform tests that have a low positive predictive value and, in many cases, may result in little clinical value. To avoid unnecessary testing and the complications that can result from pursuing false positive test results, lab tests should be done based on clinical indications and the positive and negative predictive values of relevant tests. PAT processes should be both standardized and tailored to the individual patient’s context and specific comorbidities. A preadmission testing system we developed four years ago at Sheridan Healthcare (now Envision Physician Services) includes a workflow to help anesthesia professionals quickly and efficiently determine a personalized list of the tests and exams needed to ensure each patient’s surgical readiness, based on surgery type, medical history, and comorbidities. This removed variability and significantly reduced unnecessary testing, false positives, and associated risks at our partner hospitals.

### Scheduling

A thorough and streamlined process for scheduling cases appropriately to make sure all the necessary equipment and personnel are available is needed. Double-checking the availability of both equipment and personnel at least one day prior to surgery can mitigate case delays and cancellations that can affect timely patient care.

### Multimodal Pain Management

Creating standardized, evidence-based processes for multimodal pain management is becoming an increasingly important way to promote patient satisfaction, throughput, and safety. The more we learn about effective ways to control acute perioperative pain using non-narcotic adjuvants, the more we can decrease the use of opioids, reducing patients’ exposure to the potentially serious adverse effects of those drugs.

### Structured Handoffs

Handoffs are often incomplete and/or inconsistent because of production pressure and a lack of standardization. Having every provider do a correct and complete handoff to the next provider in a standardized manner—so that, for example, every PACU or ICU nurse who receives a patient from an anesthesia provider fully understands the patient’s acute and chronic issues—may result in decreased variability and better patient outcomes.

### Protecting Patients While Increasing Efficiency

Health care providers are being pushed to do everything faster, better, and less expensively. But we still need to protect our patients and make sure we’ve performed effective time-outs. In other words, we need to “slow down (when it matters!) while speeding up” to make sure that none of the things we used to do for patient safety are missed because of speed.

Standardizing our use of The Joint Commission’s Universal Protocol decreases variability and protects patients during surgery. Standardizing evidence-based best practices throughout the perioperative period and turning them into checklists or other tools for clinicians is the most efficient, consistent way to ensure that no step is missed that could jeopardize patient safety. Encouraging a culture of safety, participation, and mindfulness during these processes is critical to their success.

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## Reducing Distractions

### “Distractions,” From Page 42

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