SURGICAL FIRE SAFETY IN A METROPOLITAN SURGERY CENTER

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By

Denise Hirsch Tola, MSN

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ABSTRACT

The components necessary to start a fire, including fuels, ignition sources and oxidizers are present in operating rooms. Fire risk assessments are tools used by surgical team members to rank the risk of a surgical fire occurring and to facilitate communication to reduce risk. Fire risk assessment tools are often inconsistently used by surgical team members. At one facility, the circulating nurse documents the fire risk assessment without engagement of the other surgical team members. The purposes of this quality improvement project conducted at a metropolitan surgery center were to improve the knowledge and awareness of the importance of surgical fire risk and to increase practitioners’ use of a fire risk assessment tool during the surgical safety communication process. An estimated 200-240 surgical fires occur annually in the U.S. All surgical team members need to be aware of surgical fire risk and communicate with team members to minimize it. Many professional and regulatory entities recommend using fire risk assessments during the surgical safety communication process to increase awareness of the risk. A quasi-experimental, before and after intervention, pilot research project utilized a purposive sample including all surgical team members of a metropolitan surgery center. The educational intervention was based on both published evidence and findings of a knowledge, attitudes and practice survey. A 10-item pre/post-test assessed knowledge, current practice and practice
intent. A follow up post-test assessed knowledge retention and practice change. Descriptive statistics were used to analyze knowledge questions and common themes were derived from the open-ended responses. The average percentage correct on the pre-test was 48.82%, the post-test 71.88% and the follow up post-test given 3 months later, was 58.57%. On the follow up post-test, 93% of participants indicated they were incorporating surgical fire prevention strategies into their practice, compared to 82% on the pre-test. A separate pre-test question specifically regarding the use of a fire risk assessment was not asked, however, 50% reported using the fire risk assessment during the surgical safety communication process post intervention. The findings suggest that a brief educational intervention regarding fire risk assessment contributes to improving staff knowledge and use of prevention strategies.
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Chapter I

Introduction

The Joint Commission for the Accreditation of Healthcare Organizations (JCAHO) considers surgical fires to be sentinel events (The Joint Commission, 2003). While their occurrence is rare, the results are devastating to patients and can exact a heavy emotional toll on the surgical staff. In 2009 The Emergency Care Research Institute (ECRI Institute, 2009), based on data from the Pennsylvania Patient Safety Authority, estimated the rate of surgical fires to be 550-650 annually in the United States. At this point in time, the rate was comparable to the rate of surgical mishaps such as retained instruments. In 2012, the occurrence of surgical fires was estimated to be 200-240 each year (Clarke & Bruley, 2012). The incidence has decreased in large part due to safety initiatives by professional organizations, government agencies and accrediting bodies to eliminate surgical fires. While their occurrence is less frequent, surgical fires continue to occur, causing unnecessary injury to patients and potentially the surgical team. Because surgical fires are rare, they are often widely publicized in the national media.

Notably, the measures that can prevent surgical fires are inexpensive to implement as they involve effective communication and acknowledgement of risk among all surgical team members. More than a decade ago, Bruley (2004) suggested that it was imperative that all members of the surgical team communicate with one another regarding fire risk and prevention. The Universal Protocol established by JCAHO to prevent wrong site, wrong procedure or wrong person surgery, requires the use of a surgical “time out” prior to skin incision whereby all surgical team members verbally verify the correctness of the aforementioned variables (U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality, 2003).
In 2009, the World Health Organization (WHO) published guidelines for safe surgery aimed at increasing patient safety during surgery (World Health Organization, 2009). The document outlined 10 objectives and related recommendations based on evidence to achieve a safe surgical environment, of which communication was a large component. This document included a surgical safety checklist intended to improve communication of the entire surgical team with the goal of reducing patient harm. The WHO guidelines included and expanded upon the Universal Protocol enacted by JACHO by identifying three critical phases for team communication: prior to induction of anesthesia, immediately before skin incision and before moving the patient out of the operating room (OR). The second phase prior to skin incision is often referred to as “the surgical time out or briefing”—it is one part of the surgical safety communication processes that was outlined in the document’s surgical safety checklist (World Health Organization, 2009).

Implementation of the surgical safety communication process is an opportune time for the surgical team to address a fire risk assessment. Moreover, clear communication and preparedness are budget neutral if utilized but can save a life, prevent injury and potentially save thousands of dollars for the organization in legal costs. Unfortunately, because surgical fires are relatively rare events, surgical teams can easily become lulled into complacency. Consequently, surgical fire risk assessments are often not put into place or simply not followed in operating rooms until a fire actually occurs (Carlson & Rice, 2015).

Description/Statement of the Problem

The OR is a unique environment in which fires can occur as every component of the fire triangle—fuel, ignition source and oxygen—is present in the OR. Surgeons utilize high-energy
electrical devices and lasers to provide hemostasis and/or remove pathological lesions. Anesthesia professionals control oxidizers such as oxygen and nitrous oxide and oxygen is routinely administered. Circulating registered nurses (RN) and surgical scrub technicians are in charge of flammable materials in the form of surgical drapes, laparotomy sponges and surgical preparation solutions. Vigilance by all team members is required to ensure the separation of the three elements required for a surgical fire.

All health care professionals are expected to adhere to standards of care. The Association of periOperative Registered Nurses (AORN) has taken a lead role in patient safety and in the education and prevention of surgical fires. The AORN recommended practice summary guide (2013) outlines surgical fire safety practices including all aspects of the fire triangle, communication processes and the use of a fire risk assessment. The topic for The Joint Commission’s sentinel event alert, Issue 29 (2003) is the prevention of surgical fires. The recommendations include education for all team members addressing each aspect of the fire triangle. The report also describes the importance of both routine testing of the team to ensure an appropriate timely response to a surgical fire and of consistent and timely reporting of surgical fires to the Joint Commission, the Food and Drug Administration (FDA) and other appropriate agencies. The FDA, as a part of the surgical fire initiative intended to foster safer practice, published recommendations to reduce surgical fire risk on its website. Details regarding each aspect of the fire triangle, the importance of clear communication between team members and the use of a fire risk assessment before each surgical procedure are recommended (U.S. Food and Drug Administration, 2014). As of July 2015, The Joint Commission and the Council on Surgical and Perioperative Safety are now leading the surgical fire initiative in the U.S. (U.S. Food and Drug Administration, 2015). Both the Anesthesia Patient Safety Foundation (APSF)
and ECRI institute have summarized best practice for the prevention of surgical fires and appropriate responses to surgical fires. Included in these recommendations are the appropriate drying time for skin preparation solutions, proper holstering of electrical equipment and proper draping techniques to minimize oxygen accumulation under the surgical drapes. For procedures above the xiphoid, room air sedation is preferred if the patient does not require supplemental oxygen and the use of a closed system for delivery of oxygen and anesthetic gases if greater than 30% oxygen concentration is required (Anesthesia Patient Safety Foundation, 2014; ECRI Institute, 2015).

The professional nurse has an obligation to practice according to the American Nurses Association Code of Ethics. Specifically, provisions three and four of the Code expound on the nurse’s professional responsibility to promote a culture of safety, protect the health of patients, and be accountable for one’s decisions (American Nurses Association, 2015). Evidence based practice guidelines aside, including implementing the use of a fire risk assessment in the operating arena of the surgery center, is ethically the right thing to do.

The organization selected for this surgical fire safety quality improvement pilot project is a surgery center in the Mid-Atlantic metropolitan region of the United States. This surgery center offers a variety of surgical services including plastic surgery, ear, nose and throat surgery such as tonsillectomy, and dental surgery. Surgical procedures above the xiphoid process are considered to be high-risk procedures for surgical fires, particularly in the presence of oxygen (ECRI Institute, 2009). Many of the surgical procedures performed at the surgery center are therefore considered high-risk procedures for surgical fires.

Prior to implementation of this project, the surgery center’s fire risk assessment consisted of five points of risk assessment (A-E) that were to be marked during the pre-operative safety
check. The fire risk assessment was reviewed and documented in the pre-operative holding area by the circulating registered nurse without involvement of anesthesia team members. Surgical fire risk was not addressed in the operating room among team members during the surgical safety communication process. Team communication regarding surgical fire risk was completely absent during all phases of the surgical safety communication process. This practice-based project intended to educate surgical team members regarding risk prevention strategies as well as team actions to take in the event of a surgical fire. Further, the goal was to inform the surgical team members about the importance of communication surrounding the prevention of surgical fires. Proper utilization of the fire risk assessment will increase the level of communication and awareness of surgical fire risk during high-risk procedures.

**Background/Significance of the Problem**

Most surgical fires occur during procedures above the xiphoid, specifically for head, face, neck, upper chest surgery or airway surgery. Forty-four percent of fires occur on the upper body and 21% occur in the airway. The remaining surgical fires occur elsewhere on or inside the body (ECRI Institute, 2009). Clarke & Bruley (2012) state that approximately one-third of reported surgical fires result in serious injury to the patient. This can have devastating emotional, physical and financial effects for the patient and their family members. The patient may suffer life-altering consequences due to disfigurement, pain and post-traumatic stress disorder (Bruley, 2009). Severe financial burden can ensue for the patient arising from healthcare costs associated with multiple corrective and cosmetic surgeries, mental and emotional health support, physical/occupational therapy and potential disability costs.

An event such as a surgical fire is traumatic for the healthcare professionals as well (ECRI Institute, 2009). Feelings of remorse and empathy for the patient, second-guessing and
blaming behavior between the surgical team can occur. Physical injury to staff has been reported in approximately six percent of reported surgical fires (Clarke & Bruley, 2012). In addition, the organization and healthcare providers may suffer financial losses due to lawsuits since these cases are considered preventable and thus usually indefensible (Cady, 2007).

A heat source, oxygen and a fuel are the components necessary for a fire to occur; this is referred to as the fire triangle (Clarke & Bruley, 2012). The surgeon controls the ignition source, usually an electrocautery device, the anesthesia professional is in charge of combustible gasses, most often oxygen and nitrous oxide. The circulating and scrub personnel are integral in ensuring that skin preparation solutions (fuel) are completely dry prior to applying drapes to the patient, as well as ensuring that saline is available on the surgical field. Seventy five percent of surgical fires are associated with an oxygen-enriched atmosphere and seventy percent involve an electrosurgical unit as the ignition source (ECRI Institute, 2009). Every member of the surgical team should be aware of the interactions of the components necessary for a surgical fire and actively work to keep them apart (ECRI Institute, 2009).

Organizational Needs Assessment

The culture of an organization is a complicated web of perspectives and synergies. Therefore, it is necessary to consider the organization’s cultural environment when attempting to initiate a change in clinical practice or policy. An organizational cultural assessment was conducted at the surgery center by the researcher. Observation, interviews of staff and administration were completed. After the cultural assessment, barriers and facilitators to change were identified in order to develop a strategy for implementation of the fire risk assessment.

Edgar Schein (1996) describes three levels of culture; that which is easily observed, beliefs and values and lastly, underlying assumptions. Schein (1996) describes various
subcultures and microcultures within an organization that contribute to its overall culture. The subcultures can be based on occupation or education, such as physicians or nurses. Further, microcultures can form around specific work areas or tasks such as anesthesia professionals, which may include physicians and nurses.

Schein (1996) identifies three “generic” subcultures. These generic subcultures are named as the operator, engineering, and executive subcultures. Each of the identified generic subcultures possesses similar assumptions. According to Schein (1996) assumptions of the operator subculture include knowledge and skill based on the primary work of the organization. This subculture is able to adapt and deal with unexpected circumstances with a high degree of interdependence. They believe themselves to be paramount to the success of the organization because of their knowledge, ability to innovate and work collaboratively. The engineering subculture is concerned about safety and interested in automated processes that eliminate human error (Schein, 2010). The engineering subculture embraces science and technology as the solution to problems.

Because the surgery center is a small setting, the educational or professional subcultures may be less prominent than the operator subculture, which is palpable throughout the surgery center (Schein, 1996). Members of the anesthesia group typify the characteristics of the engineering subculture, but overall it is the operator subculture that dominates. The team at the surgery center exhibits a high degree of trust, communication and teamwork that permeates the entire perioperative function. For example, all of the various healthcare providers are very forthright in their communication regarding expectations. New staff are indoctrinated to the flow of work and each person’s role. The circulating nurse and the certified registered nurse anesthetist (CRNA) perform the preoperative safety check together in the preoperative area; the
exception being the fire risk assessment. Once in the OR, the circulator introduces the scrub technician to the patient and his/her role during the surgery. During the induction of anesthesia, the circulator is at the CRNA’s side available to assist with airway management, if needed.

Many assumptions of the surgery center’s culture are appropriate for the nature of the “business” of the surgical theater. The operator subculture and team based group dynamic is strong and works well in the fast paced setting of the surgery center. The maturity of the group with regard to experience and tenure in the surgery center allows for great efficiency within the system. Sustaining this culture is important for the business because it promotes its financial stability. However, mature groups can become complacent, relying on their expertise; as a result, they have the potential to stifle the generation of new ideas and resist change (Schein, 2010).

There are several strengths present within the surgery center work environment that helped to facilitate the change in practice. First is the existence of a previously established culture of safety. This is evidenced by the open communication style among practitioners as well as clearly written policies. Staff members do not hesitate to speak up if something is occurring that is not appropriate or is unsafe. The maturity of the team manifests characteristics of both the operator and the engineer subcultures (Schein, 1996), representing a group that values open communication and teamwork to get the work done efficiently and safely. Because the cases are elective and the patients have many options for surgical care, all members of the team are customer driven, recognizing the need for excellence in service. Additionally, the medical director of the center is a member of the Board of Directors for the surgery center. The medical director has a keen sense of safety and was a strong advocate for correct implementation of the fire risk assessment.
Challenges to implementation of an educational program and fire risk assessment were numerous. The surgery center closes one day a year to offer educational opportunities for the staff. Because this date was not compatible with the project timeline, an alternative plan for the delivery of the educational portion of the project was required. The maturity of the group may also pose a challenge to change (Schein, 2010). Because there has never been a surgical fire at the site, the maturity of this group may put up barriers to change and offer resistance. All members of the team may not value the importance of taking the time to do a fire risk assessment during the surgical safety communication process due to production pressure. Finally, the surgeons in particular may not be vested in processes that take additional time from already tight schedules.

The willingness of staff to innovate new processes for delivery of patient care or workflow would be a paradigm shift for the core group, but one that would be worth nurturing. One way to stimulate staff generation of innovative processes is for management to empower members of the group through encouragement, reinforcement and recognition of positive contributions. Implementation of the quality improvement project was intended to further encourage staff to build on the culture of safety, which would ultimately be beneficial for the surgery center’s ability to survive and thrive, and most importantly, protect the safety of patients and staff.

**Research Question**

The research question, using the PICOT approach for purposes of this important quality improvement project, is:

Will an educational intervention related to knowledge and the importance of surgical fire risk improve operating room staff’s knowledge and awareness of the importance of
surgical fire risk and the use of a fire risk assessment tool during the surgical safety communication process?

The specific definitions of the PICOT terms applied to this quality improvement project are:

**Population** is all operating room staff including anesthesia personnel, circulating registered nurses (RN), scrub technician/nurse and surgeons in an ambulatory surgical center.

**Implementation** of an evidence based fire risk assessment during the surgical safety communication process.

**Comparison** is with the current practice, which does not address a fire risk assessment during the surgical safety communication process.

**Outcomes** – 1. Self-reported adoption of the evidence based fire risk assessment during the surgical safety communication process.

2. Self-reported surgical staff readiness to apply surgical fire preventive measures during high-risk surgical procedures will improve. This will be measured using a self-assessment pre and post implementation of the fire safety educational program.

**T** – Within a twelve-month time frame.

**EBP Model of Implementation/Change Theory**

The evidence based practice model for this surgical fire safety project is the Steven’s Star Model of Knowledge Transformation (Stevens, 2015). Kotter’s eight step process to implement change (1995) will be used to move the best evidence into clinical practice. The Steven’s Star Model aligns well and overlaps with Kotter’s change process for implementation of the practice change.

The Steven’s Star Model of Knowledge Transformation uses a five-point star surrounded by a circle, which is a clear visual for the continuous process of translation of evidence into
practice culminating with evaluation of outcomes and subsequently beginning the process over again (See Appendix A). The five star points include: 1. Discovery research; 2. Evidence summary; 3. Translation to guidelines; 4. Practice integration; and 5. Process, outcome evaluation (Stevens, 2015). The premise of the Steven’s Star Model is that knowledge transformation is required before it can be successfully utilized in the clinical arena. Until primary research is summarized, critically evaluated and translated into a useable form such as clinical practice guidelines, the applicability of the information at the point of care is limited. The Steven’s Star Model pairs well with the intended surgical fire safety project in that professional groups as well as regulatory agencies publish practice recommendations and advisories based on literature and evidence summaries. The fourth point of the Steven’s Star model, integration into practice, is the point at which Kotter’s eight step change process begins to overlap with the Steven’s Star Model.

Kotter’s eight step change process is explicit in its steps of “how to” effect change in an organization; these are important steps to incorporate in order to actually integrate change into practice. Kotter’s change process begins with creating a sense of urgency (Kotter, 1995). During the pre-operative safety check at the surgery center, the circulating nurse documented completion of the fire safety checklist; however, no communication between other team members occurred and it was not addressed during the surgical safety communication process. In a quest to create a sense of urgency, informal focus groups were planned with various staff members and conversations have taken place with the medical director, the facility administrator and the practice manager regarding a surgical fire educational opportunity for staff.

In this project, developing a coalition, the second step in Kotter’s (1995) change process, involved identifying key champions for the project. The medical director, practice manager and
facility administrator were the key champions included. The medical director is a strong patient safety advocate. Both the practice manager and facility administrator were important for the logistics of scheduling the educational portion of the project as well as helping to sustain the desired practice change, namely incorporating the fire risk assessment into the surgical safety communication process. Additionally, there were three key staff members that were identified to be a part of the guiding coalition. The identified staff members included a CRNA, a circulating RN who is also the quality improvement nurse, and a post anesthesia care unit nurse who is the occupational safety nurse for the center.

It is unclear if the intended practice change initiative is aligned with the business strategy. The management and development company that is a partner with the physician owners of the surgery center, proclaim “an outstanding patient experience” as a part of their mission statement. The surgery center’s website declares it is positioned to deliver quality, cost effective care. It is worth noting that safe patient care, while not explicitly stated in the mission statement, is often thought of as a foundation for quality care (Mitchell, 2008). Therefore, it is reasonable that patients would receive safe care. It is believed that the health care practitioners and staff value safe patient care by virtue of their shared occupation in the healthcare industry (Schein, 2010). One would expect the physician owners do not want negative publicity, legal proceedings or a large financial payout due to a surgical fire and would adopt the proposed change in practice.

Steps three and four of Kotter’s (1995) change process are intertwined. Creating and communicating the vision was the educational program that was implemented to communicate the best practices for surgical fire prevention. The entire process was vetted through the guiding coalition to be certain that it was feasible and something the staff would embrace. Once consensus on the process and program was reached, an evidence-based survey was administered
to the surgical staff. Surgical fire safety posters were acquired to hang in each of the operating rooms. The training sessions were advertised with strategically placed signs and breakfast was served during the educational intervention. Ultimately, the goal was for the fire risk assessment to be used during the surgical safety communication process to determine the risk of a surgical fire and raise the awareness of the team.

Empowering others to act on the vision involved the removal of barriers and encouraging the staff to take risks. Input from the coalition as well as the staff during informal focus groups helped to guide this fifth step in Kotter’s change process. Ideas of how to best implement the fire risk assessment and educational offering were discussed by the group.

Kotter’s (1995) sixth step, creating short-term wins, was challenging. One possibility was to conduct audits on how many cases documented the fire risk assessment during the surgical safety communication process and then celebrate with a breakfast at fifty percent compliance during a one-month time period. Another strategy discussed was to celebrate short-term successes by creating a little competition between the rooms and the team that completed the most fire safety checks would receive Starbucks gift cards.

The final two steps, consolidating improvements and institutionalizing the new evidence based practice change dovetail with one another (Kotter, 1995). Reassessing and aligning policies to capture the use of the new fire risk assessment will continue to promote use of the fire risk assessment. Reinvigorating the practice change by continually looking for ways to improve surgical fire safety will continue the forward momentum. Formation of a “fire safety team” to update staff on new information or evidence regarding surgical fire safety will also help to maintain vigilance for fire safety. Implementing a yearly fire drill and possibly designing a fire risk assessment to be a part of the pre-operative intake process are additional ways to embed fire
safety into the culture. Institutionalizing the process can be accomplished through the orientation of new hires and per diem staff. Compliance with the new practice can be added to the employee evaluation. The owners of the surgery center could capitalize on the safety culture of the organization by advertising to the public the adherence to high quality safety standards. These actions will assist in embedding the behavior into the culture until it becomes part of the cultural assumptions of the surgery center (Schein, 2010).

The fifth point of the Steven’s Star model is evaluation of health outcomes, the cost or processes (Stevens, 2015). This evaluation and monitoring of progress again aligns well with the change process as outlined by Kotter (1995). Both the Steven’s Star model and Kotter’s change process evaluate, monitor and measure progress to keep the process of change moving forward.

The two outcomes that will be measured for the surgical fire safety project are surgical staff readiness and the knowledge to apply surgical fire preventive measures during high-risk procedures. The second outcome is the self-reported adoption of the evidence based fire risk assessment during the surgical safety communication processes. Both of these outcomes will be measured through self-assessment and report.

**Definition of Terms**

For the purpose of this research the terms fire triangle, surgical fire and surgical safety communication process will be defined conceptually. Surgical fire safety, fire risk assessment and the tool used for knowledge and practice assessment is defined operationally for this project.

**Conceptual definitions**

- Fire triangle identifies the three needed components of fire; fuel, heat and oxygen (National Fire Protection Association, 2016 ).
• Surgical fire is a fire that occurs on, in or near the patient during a surgical procedure that may cause injury or death to the patient or surgical team members.

• Surgical safety communication process is a procedure whereby all members of the surgical team engage at various phases to communicate verification of the patient, procedure, equipment, medications and any safety concerns (World Health Organization, 2009).

Operational definitions

• Surgical fire safety is the use of best practices in the literature for the prevention and containment of surgical fires.

• Fire risk assessment ranks the risk of surgical fires from 0-3, with 3 being the highest risk of surgical fire using an evidence-based list of components to assess risk during a surgical procedure (Christiana Care Health System, 2010).

• The pre, post and follow up tool for knowledge and practice assessment is an eight-point multiple choice/answer knowledge survey and two practice questions with narrative option.
Chapter II

Review of the Literature

Search Criteria

The search strategy employed Boolean searching techniques and manual searching utilizing the reference lists of research articles as well as a reference list provided by Mr. Mark Bruley, a forensic investigator for the ECRI Institute. The Boolean search was completed using the four following concepts: operating room, fire, operating room personnel, and safety. Similar key terms were included in the initial searches for each concept, such as “surgery” or “ambulatory care facility” or operating room, which identified MeSH terms to widen the search. The key term “fire” was joined with “or” to “airway fire” or “burn injury” or “inhalation injury”. Operating room personnel was broken down to nurse anesthetist, anesthesiologist, or scrub technician. The terms safety or safety checklist were searched. Finally, the key terms were joined with “and” in various groupings to yield a total of 147 articles. The databases searched included Pubmed, CINAHL, and Joanna Briggs. Only those articles in English, with abstracts and within the last ten years were reviewed for inclusion and exclusion criteria. Inclusion was limited to fires occurring in the surgical field, on the patient, in the patient or patient’s airway while in the operating room. Burn injury from direct contact with devices such as warming blankets, light cords or other heat sources were excluded. Fires occurring off the surgical field were also excluded. Finally, articles discussing disaster situations or thermal injuries that occurred outside of the operating suite and electrical equipment educational review articles were excluded.

This process yielded twenty articles, seven of which were literature reviews with recommendations for best practice. Three articles described experimental studies that either
tested the flammability of fuel sources at varying oxygen concentrations or measured oxygen concentrations near the surgical site using different oxygen delivery systems. The remaining articles included survey research, practice guidelines, closed claims and legal review, case reports, and an article discussing the use of simulated experiences to improve perioperative safety. Additionally, several publications by professional organizations which address intraoperative surgical fire safety, such as the ECRI Institute (2009), APSF (2014) and the AORN (RP summary: Recommended practices for a safe environment of care, 2013) were instrumental in the writing of this paper and formulating an educational program for the surgical staff. Recent updates in the literature included three experimental research articles, additional survey review, and development of a certification program for surgical fire safety for CRNAs.

Critique and Synthesis of Previous Evidence

The evidence for surgical fire safety is largely a compilation of case reports, prospective experimental design studies that examines elements of the fire triangle and practice recommendations from professional organizations. Research studies using a mechanical model have illustrated the important relationship between oxygen concentration and the ability to ignite a fire as well as the safety of various electrosurgical devices (Roy & Smith, 2010, 2011). Roy & Smith (2015a, 2015b) also examine the ability of laser safe endotracheal tubes to withstand laser strikes, and found that the distal cuffed end of the reinforced laser endotracheal tube is not reinforced and is susceptible to ignition with a carbon dioxide (CO2) laser through inadvertent puncture of the cuff. The Roy and Smith studies are well designed and implemented, substantiating the need for vigilance, communication, proper equipment and minimizing oxygen concentrations. Meneghetti et al. (2007) compared open source oxygen delivery via nasal prongs with a naso-pharyngeal delivery system during facial surgery. It was found that the naso-
pharyngeal delivery system produced oxygen concentration close to room air at the operative site compared to nasal prongs. This study clearly demonstrated that an open delivery system of oxygen can produce high concentrations of oxygen at the surgical site when performing upper body or facial surgery. However, the use of a naso-pharyngeal delivery system as Mengheetti et al. (2007) advocates may be uncomfortable for patients and according to current recommendations by the APSF and ECRI, would not be consistent with current practice advisories.

Kung et al. (2016) evaluated the effects of vacuum suctioning and drape tenting strategies to minimize oxygen concentrations when using a nasal cannula during facial surgery. Oxygen concentration was measured and time to reach twenty-one percent concentration recorded while using vacuum suction, strategic draping or both. The research team was able to demonstrate lower concentrations of oxygen when vacuum suction was employed regardless of draping strategy (Kung et al., 2016). Nonetheless, the technique of using an open delivery oxygen system is not consistent with current recommendations.

A study by Hakim et al. (2016) compared two types of laryngeal mask airway (LMA) devices during spontaneous and positive pressure ventilation in the pediatric population and measured oxygen concentration in the oropharynx. The study determined that the LMA might not adequately seal the airway and thus may add to the risk of surgical fire. This is an important study since the LMA is becoming increasingly popular for use during certain types of ear, nose and throat surgery, particularly tonsillectomy surgery.

A study examining the flammability of fuels, namely various surgical materials such as the surgical gowns and drapes was completed by Culp, Kimbrough, & Luna (2013). The rigor of the well-designed experiment is evident in the strict adherence to precise measurements of
materials, oxygen and protocols for flammability testing. Limitations of the study included the sealed artificial environment in which the testing took place as well as the ignition source being a match rather than the usual electrocautery device. Frame by frame videography was reviewed three times and then averaged by one reviewer to ascertain burn time and ignition time. Random review by a second investigator of the frame-by-frame videography recordings analyzed by the primary reviewer was an attempt to minimize bias. The better approach may have been to have three reviewers each analyze the recordings and then average them. Findings indicate that none of the materials in the operating room would meet Consumer Product Safety Commission requirements for flammability in oxygen enriched environments. This study is an interesting study and indicates there is work that can be done in areas outside of the OR environment to decrease the risk of surgical fires.

A systematic review of the literature (Apfelbaum et al., 2013) graded scientific evidence and opinion based evidence to set forth a practice advisory for the prevention and management of surgical fires. Most all of the literature examined was observational comparison, case report, or opinion; very few randomized controlled trials have been published on the subject of surgical fire prevention. While not supported by scientific studies, this practice advisory developed by the American Society of Anesthesiologists (ASA) Task Force on Operating Room Fires is useful to guide clinical decision making for the prevention and management of surgical fires. Unfortunately, a recent survey by Schroek, Healy & Tait (2014) indicates that pediatric anesthesiologists are not in compliance with the practice recommendations for surgical fire safety advocated by the ASA for various reasons. Some of the reasons mentioned are equipment challenges in the pediatric population as well as knowledge deficits regarding the practice recommendations.
Using closed claims analysis of 103 operating room fire claims, Mehta, Bhananker, Posner, & Domino (2013) found electrocautery to be the ignition source in ninety percent of the fire claims with oxygen being the oxidizer in ninety five percent of those electrocautery fire cases. Most of the surgical fires were during monitored anesthesia care (MAC) using an open delivery oxygen system during surgical procedures involving the head, neck, and upper chest. Payments were made more often in claims involving surgical fires than non-fire claims but the dollar amount of the payment was less than in non-fire claims, with the median payout being $120,166.00 for surgical fire claims. A legal case report of a surgical fire and the implications for the practitioner indicate that because surgical fires can be prevented, most cases are indefensible due to the negligent nature of the event (Cady, 2007). Both of these articles provide support for a practice change that utilizes a fire risk assessment.

Multiple articles from authors in a variety of disciplines summarize the risk factors associated with surgical fires and promote various ways to prevent them. Gibbs (2012) summarizes three preventable OR safety risks, which include retained surgical items, wrong side surgery and surgical fires. The important point of the article is the complexity of the OR requires the individuals to function as an interdependent system, summarily better than individually. Gibbs (2012) advocates the use of a safety checklist to enhance communication and raise the awareness of providing a safe environment. It is stated that a fire risk assessment during the surgical safety communication process will help all providers to be alert and ready should a surgical fire occur.

The article by Guglielmi (2014) is particularly interesting because each member of the surgical team offers perspectives regarding the prevention and management of surgical fires. Every team member’s perspective includes the importance of both education and
communication. This message is parroted throughout the peer-reviewed literature from various professional organizations.

Two articles offer insight into educational opportunities for staff in the prevention and management of surgical fires. Mullen & Byrd (2013) describe simulation training as a useful technique to train an influx of inexperienced staff in a number of emergent operating room scenarios; one of which is a surgical fire. Many obstacles to care were not anticipated but discovered during the simulated surgical fire scenario. Simulation training is particularly helpful for the discovery of nuances in the surgical setting that can impede quick appropriate action in an emergency. Pollock (2004) discusses the specific action for anesthesia personnel to employ should a surgical fire occur. The article then reports various mechanisms to use for training such as, incorporating videos, lecture and scavenger hunts. The scavenger hunts are used as a means to locate oxygen shut off valves, fire extinguishers and needed equipment.

Two projects were found in the literature that were particularly pertinent to the pilot study conducted by this researcher. The first, a quality improvement project seeking to incorporate ambulatory specific items to a surgical safety checklist, was useful for considering the perils to avoid when attempting the implementation of a fire risk assessment during the surgical safety communication process. Morgan et al. (2013) attempted to implement seven new items addressing post-operative nausea and vomiting as well as post-operative pain to an ambulatory surgery safety checklist. Patient outcomes were compared before and after the implementation of the new checklist. Unfortunately, no significant difference in patient outcomes could be documented. The researchers indicate that the addition of the new items was cumbersome to administer with resulting non-compliance of the surgical staff (Morgan et al., 2013). This is an important point to consider when attempting to impact or change an existing practice. The
second pilot study implemented an education and training program for the intent of increasing team members’ awareness and prevention of surgical fires. A training manual was devised and content delivered to ten volunteer anesthesia practitioners. Pre and post-test assessment was used as a measure of competence which demonstrated a significant increase in knowledge (Fisher, 2015).

A case report of a surgical fire, detailed the events leading to a fire during a tracheostomy procedure and then critiques what could have been done differently to avoid the surgical fire (Paugh & White, 2005). The aspects of this case report that are useful are the explicit description of the event and how each member of the team responded to the fire. It further illustrates how quickly the fire spread and continued to burn the oxygen mask as it tracked back to the anesthesia machine despite the oxygen being turned off. All members of the team were involved in extinguishing the fire as it burned the patient, the drapes and the mask continued to burn on the floor. The surgeon removed the mask and threw it toward the floor at the head of the bed, where it continued to burn the electrical cord of the OR bed and track toward the anesthesia machine. The anesthetist had turned the oxygen off but had to stamp out the mask, the scrub nurse used saline to douse the patient. This is a vivid portrayal of the surgical fire event and the importance of every team member understanding prevention as well as what to do should a fire occur.

A study of the perception of perioperative nurses regarding what they considered the priority quality improvement projects revealed that the top two priorities were preventing wrong site/procedure/patient surgery and preventing retained surgical items (Steelman, Graling, & Perkhounkova, 2013). All of the 37,000 OR nurses with e-mail addresses in the AORN member data base were invited to participate in the electronic survey. A total of 3,137 member responses
were used for analysis. Preventing surgical fires was number seven overall, but ambulatory surgery RNs ranked the prevention of surgical fires as number five. This study was intended to assist nursing leadership with prioritization of quality improvement projects for their specific setting. This study lends support for implementation of the surgical fire safety project.

Much of the experimental research exploring various oxygen delivery systems has shown that the risk of surgical fire is ever present. Laser resistant endotracheal tubes can indeed ignite at temperatures generated by surgical ignition sources in the presence of oxygen enriched environments (Roy & Smith, 2015a, 2015b). In the pediatric population, closed systems such as the laryngeal mask airway were found to not reliably seal and oxygen concentration may be higher than expected near the airway (Hakim et al., 2016). Additionally, alternative means of delivering oxygen during deep sedation have been tested, but most do not adhere to current practice recommendations and may cause additional patient discomfort (Mengehetti et al., 2007).

Other experimental design studies have examined the effect of various draping or scavenging strategies as a means by which to minimize oxygen concentration (Kung et al., 2016). Oxygen vacuum suctioning strategies while helpful, do not reliably reduce oxygen concentration near the surgical site; it is dependent upon the strength of the suction applied as well as the appropriate placement of the suction for optimum scavenging. Many fuels such as surgical drapes and gowns would not meet Consumer Product Safety Commission requirements for flammability in oxygen enriched environments (Culp, Kimbrough, & Luna, 2013). It would appear that the elimination of surgical fires through technical applications or equipment alone is unlikely without team communication.

Enhanced team communication and education are identified as effective means to avoid surgical fires. Fisher (2015) reported implementing a training program with anesthesia
providers, which demonstrated an increase in knowledge for the prevention of surgical fires. Recommendations for improved practice to reduce the risk of surgical fires have been made by multiple professional organizations as well as by accrediting and oversight agencies. However, surgical fires continue to occur, with commiserate individual health (death and disability), economic (cost of care and of facility liabilities) and other impact. There continues to be a need for improved evidence-based tools and processes to implement them, as well as training of clinical personnel with responsibility for surgical care to ensure that recommended practices are used in the clinical arena.

**Rationale for Project**

Regulatory, research and health facility organizations – including the U.S. Food and Drug Administration, the ECRI Institute, many professional organizations, and hospitals that have experienced surgical fires – advocate using a fire risk assessment during the surgical safety communication process. The Anesthesia Patient Safety Foundation has developed an algorithm that begins by asking the question, “Is the patient at risk for a surgical fire?” (Anesthesia Patient Safety Foundation, 2014). The algorithm continues if the answer is affirmative with the following recommendations: 1) allow alcohol based preparation solutions at least three minutes of drying time and prevent pooling of solutions; 2) do not use electrocautery without prior notification to the anesthesia practitioner; 3) if oxygen is not required by the patient to maintain adequate oxygen saturation, then room air should be used; 4) if oxygen is needed, less than thirty percent fraction of inspired oxygen (FiO2) should be maintained with use of a blender device or the common gas outlet from the anesthesia machine as opposed to a side flow meter; 5) patients requiring over thirty percent FiO2 should be intubated with an endotracheal tube or a laryngeal mask airway placed; 6) in situations in which airway instrumentation is not the best
option for the patient, an open drape configuration along with insufflation of air around the surgical site should be followed, allowing maximal exposure of the surgical area to the atmosphere which will minimize oxygen accumulation around the site (Anesthesia Patient Safety Foundation, 2014).

When this project was conceptualized, the ambulatory surgery center that was the location for this quality improvement study did not address fire risk during the surgical safety communication process. Surgical fires are preventable occurrences if each member of the surgical team is informed of the risk, employs precautionary measures, and clear communication is utilized (Bruley, 2004). The purpose of this project was to improve patient safety at the surgery center by improving staff awareness and knowledge of surgical fire risk and to incorporate a fire risk assessment into the surgical safety communication process.
Chapter III

Methods

Design/Implementation Plan

This was a quasi-experimental, before and after intervention research project. The surgical staff at one surgery center anonymously completed a written survey on knowledge, attitudes and practice (KAP) of surgical fire safety, which could not be tracked back to individuals. The educational intervention followed a brief regularly scheduled staff meeting. Staff participated in a training program for surgical fire safety including the use of a fire risk assessment. Each participant in the fire safety-training program completed a pre and post-test self-assessment. Three months after the training program, the same participants were asked to complete a brief knowledge and self-reported practice survey to assess if the fire risk assessment was utilized during the surgical safety communication process. This research project was approved by the Georgetown University Institutional Review Board (IRB) and implemented pursuant to the approved procedures for the protection of human subjects.

Project Sponsors/Resources

The surgery center supported the educational effort and practice change. In addition, posters and video were utilized from various organizations such as the Anesthesia Patient Safety Foundation (Anesthesia Patient Safety Foundation, 2014), Association of periOperative Registered Nurses (In focus: Know your part in fire prevention.2011) and ECRI Institute (ECRI Institute, 2015)

Human Subjects Review

The research project was granted exempt status after review by the Georgetown IRB and has been assigned the ID number 2015-0926. The plan was also presented for approval to the
medical director of the surgery center and the practice administrator. A memorandum of understanding was signed by the researcher and the medical director of the ambulatory surgery center. The researcher completed the Collaborative Institutional Training Initiative (CITI) Program for social and behavioral research prior to undertaking this project.

The invitation letter outlined in detail the purpose of the research project, the importance of participation and the participants’ tasks. The letter clearly stated that participation was voluntary at all times and participants could withdraw without negative consequence at any point during the project. There were no anticipated risks associated with participation in this research project and should the researchers have been notified of or discovered any harm related to the project, the investigator would have immediately notified the Georgetown IRB (See Appendix B). The overall expected benefit of the research project was increased patient safety for the prevention of fires during ambulatory surgical procedures. The benefit for the participants was increased knowledge for prevention and the ability to respond effectively in the event of a surgical fire. Anonymity for the survey responses was maintained by using no identifiable markings on the surveys and through use of a locked repository for storage of completed surveys.

**Population**

The purposive sample included surgical team members of a metropolitan surgery center in the Mid-Atlantic region of the United States.

Inclusion criteria:

- full time, part time and per diem surgical team members --surgeons, anesthesia professionals, registered nurse circulators and scrubs, scrub technicians and physician assistants.

Exclusion criteria:
Pre-operative and post-operative registered nurses.

A 100% sample of eligible individuals (that is, those who met the inclusion criteria) were invited to participate in the study. A total of 55 providers were eligible to participate in the study:

22 Surgeons

12 CRNAs

18 Circulating/scrub RNs and Surgical Technicians

3 Physician Assistants

Procedures/Timeline

Flyers informing staff of the study were posted in commonly used staff areas such as locker and lounge areas. The surgical fire safety survey and a detailed invitation letter were put into envelopes and placed in the staff lounge area on a table next to the locked box designated for return of the surveys. The invitation letter explained the purpose of the research, the voluntary and anonymous nature of the research, the Georgetown IRB approval number and their contact information. An announcement made at a February staff meeting invited all surgical staff to participate. Approximately two weeks were allotted for completion and return of the surveys to the locked box. Following analysis of the results, an educational program was delivered in early March prior to the start of the day’s surgical cases. Prior to the start of the educational program, staff was asked to complete a brief pre-test, followed by a post-test after program completion. Approximately, three months following the educational program the staff that were in attendance for the educational program were asked to complete a follow up survey that included questions regarding knowledge and current practice related to fire safety to measure the impact of the education on knowledge and practice.
Instruments/Tools

The surgical fire safety survey was adapted from a survey tool used in a previous research project (Ransom, Kienle, Loshonkohl, & Tank, 2014). This research project is unpublished and permission for adaptation and use of the survey was obtained from two of the four prior students that created the tool. The other two former students did not respond to email and no other means of contacting them was available. The survey tool was altered to reflect the target population in the surgery center and to capture the practice at the surgery center.

The purpose of the adapted survey tool was to elicit information that could be used to tailor the educational program to the needs of the staff. The tool consisted of a total of twenty-seven questions. The first five questions collected demographic information, followed by sixteen knowledge and practice questions. The remaining six questions consisted of practice and attitude questions, two of which were open-ended questions exploring facilitators and barriers to surgical fire safety knowledge and adherence to guidelines. All other questions were multiple choice or multiple answer questions.

Five experts reviewed the survey for content validity. The experts included two CRNAs; one is an educator and the other is a chief CRNA at a large hospital that experienced a surgical fire. One expert is a DNP prepared director in the department of surgery and the education and clinical director. The fourth expert is the vice president for accident and forensic investigation at ECRI Institute and the fifth is a Joint Commission consultant. All reviewers provided comments and suggestions, which were incorporated into the final fire safety survey (See Appendix C). The final survey format was reviewed for a second time by four of the five experts (one did not respond).
The pre and post-tests that were administered immediately before and after the educational program were a shortened ten-question version of the adapted survey (See Appendices D, E). The knowledge questions related to each aspect of the fire triangle. The last question in the pre and post-tests assessed the use of fire prevention strategies including a fire risk assessment. The pre-test asked if prevention strategies such as a fire risk assessment were the current practice and the post-test asked if these prevention strategies would be incorporated into their practice following the educational program. Three months later, the follow up post-test was administered. The follow up post-test included the same knowledge questions that appeared on the pre and post-tests but also asked two additional questions regarding how practice had been altered and allowed opportunity for comment (See Appendix F). The first inquired whether practice was altered and how it was altered. The second question specifically asked if a fire risk assessment was used during the surgical safety communication processes for all procedures, how it was used and if not—why not?

Outcome Measurements/Data Analysis Plan

Outcomes measured included improvement in readiness to apply surgical fire preventive measures as demonstrated by a twenty-five percent increase in score on the post-test knowledge questions. The ultimate goal was the adoption of the fire risk assessment and its use during the surgical safety communication process one hundred percent of the time. This was measured through self-reported data at the three-month time interval post intervention.

Data analysis included descriptive statistics to represent the group demographic characteristics. This included information such as level of education, years of experience and primary role in the operating room. Descriptive statistics were also used to analyze the knowledge portion of the survey. Two sample tests of proportion were used to compare pre to
post, pre to follow up post and post to follow up post-test to determine if there was a difference in knowledge and attitudes before the training intervention compared to after the training. The three month follow up post-test provided information regarding the sustainability of knowledge, attitudes and the practice change through self-report. The open ended questions on the follow up post-test were explored for common themes.
Chapter IV
Evaluation and Results

Analysis of Data

**Pre intervention survey.** The purpose of the pre intervention surgical fire safety survey was to inform the development of the fire safety intervention. This survey was completed by 13 individuals, all of whom were surgical personnel in the facility in which the quality improvement project was conducted. Given that the total number of surgical personnel working in the surgical unit was 55; this represents 24% of potential respondents.

**Demographics.** Demographic information was collected only from the survey that was used to elicit information to design the intervention. No demographic data were collected from the pre-post intervention surveys.

The 13 respondents to the survey included five anesthesia professionals, four surgical technicians, three circulating nurses and one physician’s assistant. No surgeons participated in the pre intervention survey, nor did they attend the training session. Sixty-nine percent of the respondents had greater than 15 years of experience in their respective role. A master’s degree was reported by 23% of the respondents as the qualifying degree for their practice; baccalaureate preparation was reported by 23%. Thirty-eight percent reported an associate degree and 15% had either a diploma or certificate qualifying them to practice. Only one person reported working primarily in a facility with 300-500 beds, the rest of those reporting worked in the ambulatory setting only.

**Prior experience with surgical fires.** Five respondents (just over one-third) reported having worked in a facility that had a surgical fire and two of these were personally involved in a
surgical fire. Seventy-seven percent of the staff surveyed agreed that the facility was ready to address the surgical fire safety.

**Fire safety training.** Over three-quarters of those surveyed reported their primary source of fire safety training as employee based inservices or online educational modules. Only one individual reported simulation or fire drills as a part of the training. Fire safety training was reported by 62% of the respondents as required at a minimum annually, while 38% either reported training only upon hire, never, or unknown requirements.

**Facilitators and barriers to knowledge and guideline adherence.** Five of 13 respondents (38%) stated that the lack of education was a barrier. Three responded that better communication was needed. One stated it should be in the “time out”. Two others reported, “it’s just not talked about because of the infrequency of surgical fires.” Another barrier mentioned was production pressure “time is money”. Facilitators cited by several respondents included additional training, more drills, and a simple protocol for addressing fire risk.

**Pre, post and follow up post-tests.** Seventeen staff—including anesthesia professionals, operating room nursing staff and surgical technicians—participated in the pre-test and surgical fire education training. Post intervention, 16 individuals completed the KAP survey. Three months post intervention, 14 surgical staff who attended the training completed follow up surveys.

**Respondent knowledge regarding surgical fires.** The knowledge portion of the pre, post and follow up post-tests included eight questions; these results were examined using descriptive statistics and two-sample tests of proportion pre to post, pre to follow up and post to follow up. The average percentage correct on the pre-test, post-test and follow up post-test are as follows:
pre-test, 48.82%; post-test 71.88 %; follow up post-test 58.57%. The results for each question are shown in Table 1.

Table 1. Knowledge questions percent correct.

<table>
<thead>
<tr>
<th>% Correct</th>
<th>Q1 Fire triangle</th>
<th>Q2 CMC</th>
<th>Q3 Ignition sources</th>
<th>Q4 Safe O2 delivery</th>
<th>Q5 Alcohol preps</th>
<th>Q6 Fire on patient</th>
<th>Q7 Fuels</th>
<th>Q8 Airway fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre test 17 respond</td>
<td>76.47</td>
<td>76.47</td>
<td>29.41</td>
<td>17.64</td>
<td>58.82</td>
<td>70.58</td>
<td>0</td>
<td>35.29</td>
</tr>
<tr>
<td>Post test 16 respond</td>
<td>81.25</td>
<td>93.75</td>
<td>25</td>
<td>31.25</td>
<td>68.75</td>
<td>93.75</td>
<td>50</td>
<td>93.75</td>
</tr>
<tr>
<td>Follow up post test 14 respond</td>
<td>71.42</td>
<td>85.71</td>
<td>35.71</td>
<td>28.57</td>
<td>85.71</td>
<td>78.57</td>
<td>7.14</td>
<td>50</td>
</tr>
</tbody>
</table>

The tests of proportion were calculated using STATA 14. The \( p \) values for one tailed tests of proportion for the pre-test to post test, the post-test to follow up test and the pre-test to follow up test were \( z = 1.35; p = 0.09 \), \( z = 0.77; p = 0.22 \) and \( z = 0.54; p = 0.29 \) respectively. No significant difference was detected in any of the comparisons.

**Respondent self-reported practices related to surgical fire prevention.** Two questions that asked the respondents to self-report practices related to surgical fire prevention were included at the end of each of the tests. The first question inquired if the participant perceived himself/herself as competent in strategies for the prevention and management of surgical fires. For the pre-test, 41% reported competence in both the prevention and management of surgical fires, whereas 87.5% reported feeling competent in the prevention and management on the post-test.

The second personal practice question addressed the implementation of prevention strategies and alterations in the participant’s practice. Slightly different phrasing was used to ask the question pre to post to follow up post-test. The purpose was to ascertain practice prior to the intervention, intent to change practice (behavioral intent) and in the follow up post-test, if in fact
practice was changed and whether a fire risk assessment was a part of their fire prevention strategies. Fourteen, or 82% of the pre-test participants reported incorporating preventive strategies in their practice. The post-test participants unanimously reported that they would indeed incorporate prevention strategies into their practice (that is, behavioral intent). The follow-up post-test asked if respondents were incorporating prevention measures into their practice and separately asked whether a fire risk assessment was a part of the prevention strategies that they implemented. The follow up post-test indicated that 13 of the participants (93%) were incorporating surgical fire prevention strategies into their practice. Some of the participants also provided comments about their prevention strategies. For example, 71% of respondents report increased drying time for prep solutions and being generally more “aware” of the danger posed when oxidizers are used in the presence of ignition sources. Improved communication was specifically reported by nine of the respondents reporting a change in their practice. A question that separately inquired regarding the use of a fire risk assessment as a preventive strategy was only included in the follow up post-test. Seven of the 13 respondents who have incorporated prevention strategies into their practice reported using a fire risk assessment during the surgical safety communication process as a part of their prevention strategies. Of those reporting not using a fire risk assessment, one person reported that they were “getting used to the new time out” while another stated “the fire risk assessment is initiated by anesthesia” and yet others reported it is not done during the surgical time out but it should be completed at this time.

**Summary of Findings/Outcomes**

The self-reported follow up test indicates that staff knowledge regarding surgical fires did not improve from a statistically significant standpoint. However, the 14 individuals who work in
this surgical center that participated in the follow up survey all showed improved knowledge scores regarding prevention of surgical fires. Most – 13 out of 14 reported that they had been utilizing fire prevention strategies in their practice since the intervention. The second outcome of the fire risk assessment being utilized during the surgical safety communication process was reported at 50% of the time rather than the goal of 100% compliance. Nonetheless, at least half of the respondents reported that they were incorporating a fire risk assessment into their practice during the surgical safety communication process at follow up.
Chapter V  
Discussion and Conclusions

Discussion of Findings

The Emergency Care Research Institute (ECRI Institute, 2015) estimates the occurrence of surgical fires to be 200-240 each year. Surgical fires can be prevented through effective team communication and increased knowledge of risk factors and the role of each team member in prevention. These measures are inexpensive to implement and are recognized by professional organizations and accrediting bodies as best practices. The use of a fire risk assessment can be used to elucidate and discuss steps to minimize surgical fire risk during the surgical safety communication process.

The purpose of this project was to increase the surgical staff’s knowledge of surgical fire safety and the use of a fire risk assessment during the surgical safety communication process in the minimization of that risk to improve patient safety. The follow up post-test reveals that the knowledge of fire safety was not improved from the standpoint of statistical significance. However, this was necessarily a small sample – a facility-based quality improvement project carried out in a surgical center in which there is a total of 55 surgical staff, of which 24% participated in the project. Moreover, given that 13 of the 14 follow up post-test respondents reported incorporating safety measures into their respective areas of practice, indicates there has been an increase in the awareness of surgical fire safety and this can potentially save a life.

After implementation of the project, the fire risk assessment was modified by the researcher to reflect the Christiana Care Health System’s fire risk assessment. The importance of this was to better target the fire risk assessment to capture the main risks for surgical fire risk; that is surgery above the xiphoid process, use of an ignition source and the use of an open source
of oxygen or nitrous oxide. The revision was based on comments from the staff that better communication and a simple protocol was needed. The intention was to facilitate the efficient use of the fire risk assessment.

The results of this study are consistent with a recently published study by Fisher (2015); this was a small pilot study of anesthesia providers. Using a pre/post-test design Fisher was able to demonstrate an improvement in fire safety knowledge after the intervention. The current study differs in that all members of the surgical team were invited to participate. It also demonstrates that there is a small decrease in retention of knowledge in the following months post intervention, but some retention of knowledge persisted and half of the participants are utilizing a fire risk assessment during the surgical safety communication process. This lends itself to building upon retained knowledge, sustaining and enhancing the practice change, and exploring opportunities for increased compliance.

Limitations

Several limitations were evident in this quality improvement, unit-based project, which included a small purposive sample of convenience that was regionally based. The necessarily small sample size limited the choice of statistical tests that could be utilized for data analysis as well as the ability to show statistical significance for the results of the project. To protect the identity of the participants in this small group, the various staged tests were not paired. Consequently, paired t tests could not be completed. The research was regionally based and conducted in a private surgery center, thus the results cannot be generalized to other practice groups in different types of practice environments or to a different area of the country.

While the knowledge questions on the pre, post and follow up post-tests were identical, the practice questions were intentionally phrased differently to capture actual practice, intent to
change and actual practice three months later. This however, caused some difficulty in analysis. The pre and post-tests included a “fire risk assessment” as one example of a preventive measure that was used or planned to be used and did not separately ask if a fire risk assessment was completed nor was the timing for completion of a fire risk assessment addressed. The last question on the follow up post-test inquired specifically if during the surgical safety communication process a fire risk assessment was completed. This was not asked separately in the pre or post-tests. This made it difficult to determine how often a fire risk assessment was actually completed as a team on the pre-test prior to the intervention; though based on the researcher’s experience at the facility and surgical staff comments on the initial survey, it was not being done.

Finally, the practice changes were self-reported without clinical documentation or audits to corroborate the reported changes. It is possible that some participants responded as they thought they were expected to respond in order to demonstrate compliance with the intent of the project. Great care was taken to prevent any linkage of the surveys, pre, post or follow up post-tests with any individual, with the intent of minimizing this possibility.

**Implications for Practice, Education and Policy**

Despite the rarity of surgical fires, the damage they cause can be significant. It is therefore necessary to create ways of maintaining staffs’ awareness of surgical fire risk. While this pilot research study did not yield significant statistical results there are positive implications for practice at the surgery center. The self-reported knowledge gains in surgical fire safety as well as the positive practice changes will require continued knowledge reinforcement to keep it at the forefront of attention and continue the momentum forward. This can be accomplished through educational offerings in the workplace in the form of in-service education, online
modules and simulated experiences or drills at the surgery center. The various educational offerings should become an annual competency. Education for all surgical team members as well as ongoing testing is a recommendation from JCAHO regarding surgical fire safety (The Joint Commission, 2003). Role-playing could be a useful tool to promote a comfort level for initiating the fire risk assessment during the surgical safety communication process.

The fire risk assessment was reported by half of the surgical personnel as being completed during the surgical safety communication process. It is essential to continue this forward progress by reinforcing and reinvigorating the process. This could be done with the creation of a fire safety team. This team could take responsibility for giving a fire safety update at the scheduled staff meetings; this would serve as a regular reminder for vigilance in preventive efforts. Updates could include current status of compliance with the fire risk assessment, evaluation of the current process and soliciting input for ways to improve the process. Recent updates from regulatory agencies as well as new surgical fire safety articles could also be included.

This surgery center utilizes the services of part-time and contract per-diem staff. It is essential that all surgical staff working in the center be familiar with surgery center’s policies regarding surgical fire safety. In addition, surgical fire prevention measures should be included as a part of their orientation to the facility.

This pilot project addressed fire safety using an interdisciplinary format across the surgical team members. It is important to note that no surgeons participated in the education or completed an initial survey. A culture of safety is absolutely required to support any safety initiative and its sustainability. This requires interdisciplinary involvement in the process. Increased efforts to specifically include surgeons in educational opportunities at the surgery
center needs to be addressed. An interdisciplinary approach to patient safety efforts is supported throughout the literature used in the preparation of this project.

An opportunity to increase patient safety through system enhancement also exists at the surgery center. When a high-risk surgical case is scheduled, the chart could be flagged as being “high risk for surgical fire”. This would include all surgery above the xiphoid process and would serve as an additional reminder to surgical staff that preventive measures should be taken. This technique also has possibilities in larger institutions with electronic health records (EHR). A program could easily be incorporated into an EHR to flag high fire risk surgical cases.

It would be useful to examine the reasons that half of the time a surgical fire risk is not addressed. To begin a discussion at the surgery center, a focus group is planned for late fall 2016. Topics for discussion would include evaluation of the fire risk assessment tool, barriers to using the tool and suggestions that might improve the process.

Clearly written, communicated and updated policies in healthcare settings are required. The fire safety program policy at the surgery center requires revision to align with the updated fire risk assessment and its use. The old policy states the circulating nurse will report the fire risk before the procedure begins and state any combination of letters, A through E that coincided with the risk assessment. A revised policy should clearly state who should participate in the fire risk assessment and at which phase during the surgical safety communication process it should be addressed.

On a broader scale, it is necessary to begin the education of surgical fire safety at the “student” level. Particularly, this is important for those training programs that instruct students intending to enter the surgical arena. All students of surgery, anesthesia, and nursing should
receive instruction about the risks and prevention of surgical fires. An interdisciplinary approach would be best to achieve a collaborative approach to this safety problem.

**Recommendations for Further Study**

The positive trends in knowledge scores immediately post-test and at the three-month follow up evaluation warrant further research with an adequately powered study. A larger research study involving multiple sites would provide more complete information regarding how knowledge translates into practice. The secondary benefit of a larger study is that more personnel could be educated in the prevention of surgical fires.

Further research examining communication barriers and facilitators between healthcare providers may provide answers as to why safety checklists and other safety tools may not be followed. Clinical simulation is one way to bring all members of the surgical team together for an educational endeavor and an exercise in team building and improving communication. Other team building and multidisciplinary exercises can be explored that may increase the likelihood of improved communication.

Minimizing surgical fire risk through research and development in other venues would also be helpful. As noted in the studies by Culp, Kimbrough, & Luna (2013) and Roy & Smith (2015a, 2015b) much of the surgical equipment used in the OR is not manufactured for optimum fire safety. Examples of research opportunities include: developing new materials that are fire resistant in oxygen enriched environments; developing better materials for the airway that resist ignition from lasers; or developing cautery and laser equipment with sensors that would disable the device in the presence of oxygen enriched environments are a few areas that warrant exploration.
Based on the literature, effective team communication and the use of fire risk assessments are paramount to eliminate the risk of surgical fires. However, there are many avenues that could be explored to improve equipment used in surgical procedures and new electronic health record systems that can be programmed to deliver reminders of high risk procedures. It is necessary to maintain vigilance and continue to incorporate surgical fire safety into our operating rooms to eradicate these events that cause mortality and morbidity, including emotional and psychological consequences. It is also necessary to examine all potential means by which to minimize the risk of surgical fires.
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Appendix A

Evidence Based Practice Model

Appendix B

Participant Invitation Letter

Dear Surgery Center Staff Member,

You are invited to participate in a research study titled “Surgical Fire Safety in a Metropolitan Surgery Center.” Denise H. Tola MSN CRNA and Doctoral candidate in the Doctor of Nursing Practice Program at Georgetown University is conducting this study. This study will elicit information regarding surgical fire safety prevention, knowledge and adherence to surgical fire safety prevention methods among Surgery Center staff. The results will be used to develop a training module and potentially influence current policy and procedure development related to surgical fire safety.

Participation in this study is entirely voluntary at all times. You can choose not to participate at all or to leave the study at any time. Regardless of your decision, there will be no effect on your relationship with the researcher or any other negative consequences.

There are three parts to the study: 1) the current brief survey, in which you will be asked to complete a survey regarding knowledge of surgical fire safety in the operating suite and your role in prevention or treatment; 2) a brief educational intervention that will be designed based in part on the results of this survey; and 3) a brief survey that you will be asked to complete after the educational intervention. Your informed consent will be requested for each of these parts of the study.

The current survey should take around 10 minutes to complete. A locked box will be located in the lounge area for you to deposit completed surveys. If at any point during your completion of the survey you are distressed by any of the questions, you may cease completion of the study and not submit it. However, there will be no way to withdraw from the study once you have deposited the completed survey in this box because the survey contains no identifying information. If you complete less than 20% of the questions, your survey cannot be included in the results.

Permission to conduct the study has been obtained from the Institutional Review Board of Georgetown University. The IRB approval number is: 2015-0926. All responses to this survey are strictly anonymous and cannot be linked to you in any way. The researcher will maintain security by keeping the documents password protected on a single personal computer in a locked office that is accessible to only the researcher. Hard copies of Excel files will be kept in the same locked office, in a locked file cabinet, and there will be no unique identifiable data requested or recorded by the researcher. Data collected by the researcher will be destroyed 36 months after the post-intervention survey has been conducted.

Information collected in this study may contribute to the development of surgical setting education and training thereby assisting staff by improving readiness to act in the event of a surgical fire as well as increasing awareness of ways to prevent surgical fires. The findings from this study may influence current policy and procedure development related to surgical fire safety at the Center and possibly in other facilities as well. There is also the potential for the findings to
be applied to improve patient safety processes, cost effectiveness, and provider communication. Finally, the findings may be used as the basis for further study of barriers associated with non-adherence to surgical fire safety guidelines.

If you have any questions regarding the survey or this research project in general, please contact the researcher Denise H. Tola at 202-687-8123 or via email at Denise.Tola@georgetown.edu

By completing and submitting this survey, you are indicating consent and agreeing to participate in this study.

Denise H. Tola MSN CRNA
Georgetown University
Denise.Tola@georgetown.edu
202-687-8123

Georgetown University IRB
irboard@georgetown.edu
202-687-1506
Appendix C

Reviewed Surgical Fire Safety Survey

Surgical Fire Safety in a Metropolitan Surgery Center: A Survey
Denise H. Tola MSN CRNA
January 2016

Surgical Fire Safety Data Collection Tool

This data collection tool contains three sections. The first section of the tool contains demographic questions. The second section contains questions regarding surgical fire safety, some of which are based on published ECRI Institute and Food and Drug Administration (FDA) recommendations. The last section is open-ended questions.

Demographics

Please choose the best or most applicable answer for the following six questions.

1. What is your primary role in the operating room?
   a. Surgeon
   b. Scrub RN
   c. Scrub LPN
   d. Surgical technician
   e. Surgical Assistant
   f. Physician assistant/RNFA
   g. Anesthesia practitioner
   h. Circulating RN

2. How many years have you been practicing in your primary role?
   a. 1-2 years
   b. 3-5 years
   c. 6-10 years
   d. 11-15 years
   e. Greater than 15 years

3. In which type of facility do you primarily practice?
   a. Same day surgery center/office
   b. Academic/teaching institution
   c. Military hospital or facility
   d. Community hospital
   e. Moderate to large tertiary care hospital

4. What size is the facility in which you primarily practice?
   a. No beds, outpatient facility
b. Less than 100 beds
c. 100-300 beds
d. 301-500 beds
e. 501-700 beds
f. Greater than 700 beds

5. What level of education qualified you for the current position you hold in the operating room?
   a. Certificate
   b. Diploma
   c. Associate degree
   d. Baccalaureate degree
   e. Master’s degree
   f. Doctoral degree

_Surgical Fire Safety_

Please choose the best or most applicable answer for the following questions; unless indicated select only one answer.

6. There are 200-250 fires that occur in, on or around a patient having a surgical procedure each year. These fires are preventable.
   a. True
   b. False

7. Was surgical fire safety education provided and/or required in your educational program?
   a. Yes, surgical fire safety education was provided and required in my educational program.
   b. Yes, surgical fire safety education was provided in my educational program but was not required.
   c. No, surgical fire safety education was not provided in my educational program but obtaining surgical fire safety education from an outside institution was required by my educational program.
   d. No, surgical fire safety education was not provided in my educational program and was not required from an outside institution by my educational program.

8. My current primary source of surgical fire safety education and/or training is:
   a. Workplace in-service educational training
   b. Team simulation/drills
   c. Employee online modules
   d. Educational conferences or professional development conferences
   e. Other, specify
   f. None - I am not required to complete surgical fire safety training
9. How often does your workplace require competencies or continuing education regarding surgical fire safety prevention?
   a. Never
   b. Upon hire only
   c. Only when there is a fire reported in the surgical setting
   d. Annually
   e. Every 2 to 5 years
   f. Other, specify
   g. I don’t know

10. Have you worked in a facility that experienced a surgical fire during your employment with the facility?
    a. Yes
    b. No

11. Have you personally experienced a surgical fire during a surgical case with which you were involved?
    a. Yes
    b. No
    11.1 If yes, please comment on what you believe could have been done to prevent the surgical fire.

12. Have you participated in a fire drill while working in the operating room?
    a. Yes
    b. No

13. The Fire Triangle consists of the following:
    a. Air, fuel, and combustion
    b. Air, triggers, and ignition source
    c. Oxygen, fuel, and ignition source
    d. Oxygen, fuel, and combustion
    e. I don’t know

14. What do ECRI Institute surgical fire safety guidelines recommend as the most effective tool for preventing surgical fires?
    a. Communication amongst the surgical team
    b. Avoiding use of polyvinyl chloride endotracheal tubes during surgeries of the head and neck
    c. Use of non-flammable surgical drapes
    d. Use of supplied oxygen concentration of less than 30% via nasal cannula or disposable face mask during surgeries of the head and neck
15. According to ECRI Institute surgical fire safety guidelines, which of the following devices have the potential to ignite a fire in the operating room? Please choose all that apply.
   a. Laser
   b. Electrocautery/Electrosurgery
   c. Defibrillators
   d. Fiberoptic lights
   e. High speed burs
   f. I don’t know

16. According to ECRI and FDA surgical fire safety guidelines, which is appropriate for safe oxygen delivery during surgical procedures of the head, face, neck and upper chest? Please choose all that apply.
   a. Use an open delivery oxygen system such as a nasal cannula combined with drape tenting to minimize oxygen buildup
   b. Use a closed system such as an endotracheal tube or laryngeal mask airway if greater that 30% oxygen is required
   c. Evaluate if supplemental oxygen is required by the patient
   d. Minimize oxygen accumulation with open draping techniques and insufflating air over the face where an airway device is not feasible
   e. I don’t know

17. According to the FDA, which of the following are recommended safety measures when using alcohol based skin preparations? Please choose all that apply.
   a. Allow adequate drying time as prescribed in the labeling for the specific product
   b. Drape the patient before the skin preparation solution is completely dry
   c. Prevent pooling of alcohol based skin preparation solutions
   d. Remove alcohol soaked materials from the prep area before draping
   e. Extend the drying time for hairy areas or skin folds where alcohol skin preparations are used
   f. I don’t know

18. According to ECRI Institute surgical fire safety guidelines, the anesthesia provider’s first priority in the event of a surgical fire on or around the patient is to:
   a. Notify the OR front desk
   b. Remove the tracheal tube
   c. Stop flow of gas
   d. Remove the ignition source
   e. Smother the fire
   f. I don’t know
19. According to ECRI Institute and the FDA which of the following are considered fuels? Please choose all that apply.
   a. The patient
   b. Surgical drapes
   c. Alcohol based skin preparations
   d. Oxygen
   e. Electrocautery
   f. I don’t know

20. Which of the following substances perform as oxidizers in a surgical fire? Please choose all that apply.
   a. Nitrous oxide
   b. Oxygen
   c. Carbon monoxide
   d. Alcohol prep solution
   e. Betadine
   f. Medical air
   g. Collodion (liquid skin dressing)
   h. I don’t know

21. According to ECRI Institute guidelines, in the event of an airway fire what level of oxygen is recommended during ventilation until the airway fire is extinguished and residual airway devices removed from the airway?
   a. 15%
   b. 21%
   c. 35%
   d. 50%
   e. 75%
   f. I don’t know

22. Do you feel competent in preventing and managing a surgical fire? (Do you think you possess both the knowledge and skills necessary to prevent and manage a surgical fire?)
   a. Yes, competent in both prevention and management of surgical fire
   b. Yes, competent in prevention, but not competent in management of surgical fire
   c. Yes, competent in management, but not competent in prevention of surgical fire
   d. No, not competent in management or prevention of surgical fire

23. During procedures that have high risk of surgical fire, how often do you incorporate surgical fire prevention strategies into your practice?
   a. Never
   b. Rarely
   c. Sometimes
   d. Frequently

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24. Does your primary work facility perform a fire risk assessment prior to each surgical procedure?
   a. Never
   b. Rarely
   c. Sometimes
   d. Frequently
   e. Always
   f. Only for head and neck procedures
   g. Only for ENT or dental procedures

25. In your opinion, is your facility ready to address surgical fire safety education and initiatives?
   a. Yes
   b. No
   25.1 Why or why not?

Potential Barriers

26. In one to two sentences, please list and/or describe potential barriers to knowledge of and adherence to surgical fire safety guidelines during surgical procedures of the head and neck.

Potential Facilitating Factors

27. In one to two sentences, please list and/or describe potential facilitating factors related to knowledge of and adherence to surgical fire safety guidelines during surgical procedures of the head and neck.
Appendix D

Surgical Fire Safety Pre-Test

Pre-Test

Please choose the best or most applicable answer for the following questions; unless indicated select only one answer.

1. The Fire Triangle consists of the following:
   a. Air, fuel, and combustion
   f. Air, triggers, and ignition source
   g. Oxygen, fuel, and ignition source
   h. Oxygen, fuel, and combustion
   i. I don’t know

2. What do ECRI Institute surgical fire safety guidelines recommend as the most effective tool for preventing surgical fires?
   a. Communication amongst the surgical team
   b. Avoiding use of polyvinyl chloride endotracheal tubes during surgeries of the head and neck
   c. Use of non-flammable surgical drapes
   d. Use of supplied oxygen concentration of less than 30% via nasal cannula or disposable face mask during surgeries of the head and neck
   e. I don’t know

3. According to ECRI Institute surgical fire safety guidelines, which of the following devices have the potential to ignite a fire in the operating room? Please choose all that apply.
   a. Laser
   b. Electrocautery/Electrosurgery
   c. Defibrillators
   d. Fiberoptic lights
   e. High speed burs
   f. I don’t know

4. According to ECRI and FDA surgical fire safety guidelines, which is appropriate for safe oxygen delivery during surgical procedures of the head, face, neck and upper chest? Please choose all that apply.
   a. Use an open delivery oxygen system such as a nasal cannula combined with drape tenting to minimize oxygen buildup
b. Use a closed system such as an endotracheal tube or laryngeal mask airway if greater that 30% oxygen is required
c. Evaluate if supplemental oxygen is required by the patient
d. Minimize oxygen accumulation with open draping techniques and insufflating air over the face where an airway device is not feasible
e. I don’t know

5. According to the FDA, which of the following are recommended safety measures when using alcohol based skin preparations? Please choose all that apply.
   a. Allow adequate drying time as prescribed in the labeling for the specific product
   b. Drape the patient before the skin preparation solution is completely dry
   c. Prevent pooling of alcohol based skin preparation solutions
   d. Remove alcohol soaked materials from the prep area before draping
   e. Extend the drying time for hairy areas or skin folds where alcohol skin preparations are used
   f. I don’t know

6. According to ECRI Institute surgical fire safety guidelines, the anesthesia provider’s first priority in the event of a surgical fire on or around the patient is to:
   a. Notify the OR front desk
   b. Remove the tracheal tube
   c. Stop flow of gas
   d. Remove the ignition source
   e. Smother the fire
   f. I don’t know

7. According to ECRI Institute and the FDA which of the following are considered fuels? Please choose all that apply.
   a. The patient
   b. Surgical drapes
   c. Alcohol based skin preparations
   d. Oxygen
   e. Electrocautery
   f. I don’t know

8. According to ECRI Institute guidelines, in the event of an airway fire what level of oxygen is recommended during ventilation until the airway fire is extinguished and residual airway devices removed from the airway?
   a. 15%
   b. 21%
   c. 35%
   d. 50%
9. Do you feel competent in preventing and managing a surgical fire? (Do you think you possess both the knowledge and skills necessary to prevent and manage a surgical fire?)
   a. Yes, competent in both prevention and management of surgical fire
   b. Yes, competent in prevention, but not competent in management of surgical fire
   c. Yes, competent in management, but not competent in prevention of surgical fire
   d. No, not competent in management or prevention of surgical fire

10. During procedures that have high risk of surgical fire, do you incorporate surgical fire prevention strategies such as a fire risk assessment into your practice?
   a. Yes
   b. No
Appendix E

Surgical Fire Safety Post-Test

Post-Test

Please choose the best or most applicable answer for the following questions; unless indicated select only one answer.

1. The Fire Triangle consists of the following:
   a. Air, fuel, and combustion
   j. Air, triggers, and ignition source
   k. Oxygen, fuel, and ignition source
   l. Oxygen, fuel, and combustion
   m. I don’t know

2. What do ECRI Institute surgical fire safety guidelines recommend as the most effective tool for preventing surgical fires?
   a. Communication amongst the surgical team
   b. Avoiding use of polyvinyl chloride endotracheal tubes during surgeries of the head and neck
   c. Use of non-flammable surgical drapes
   d. Use of supplied oxygen concentration of less than 30% via nasal cannula or disposable face mask during surgeries of the head and neck
   e. I don’t know

3. According to ECRI Institute surgical fire safety guidelines, which of the following devices have the potential to ignite a fire in the operating room? Please choose all that apply.
   a. Laser
   b. Electrocautery/Electrosurgery
   c. Defibrillators
   d. Fiberoptic lights
   e. High speed burs
   f. I don’t know

4. According to ECRI and FDA surgical fire safety guidelines, which is appropriate for safe oxygen delivery during surgical procedures of the head, face, neck and upper chest? Please choose all that apply.
   a. Use an open delivery oxygen system such as a nasal cannula combined with drape tenting to minimize oxygen buildup
b. Use a closed system such as an endotracheal tube or laryngeal mask airway if greater than 30% oxygen is required
c. Evaluate if supplemental oxygen is required by the patient
d. Minimize oxygen accumulation with open draping techniques and insufflating air over the face where an airway device is not feasible
e. I don’t know

5. According to the FDA, which of the following are recommended safety measures when using alcohol based skin preparations? Please choose all that apply.
   a. Allow adequate drying time as prescribed in the labeling for the specific product
   b. Drape the patient before the skin preparation solution is completely dry
   c. Prevent pooling of alcohol based skin preparation solutions
   d. Remove alcohol soaked materials from the prep area before draping
   e. Extend the drying time for hairy areas or skin folds where alcohol skin preparations are used
   f. I don’t know

6. According to ECRI Institute surgical fire safety guidelines, the anesthesia provider’s first priority in the event of a surgical fire on or around the patient is to:
   a. Notify the OR front desk
   b. Remove the tracheal tube
   c. Stop flow of gas
   d. Remove the ignition source
   e. Smother the fire
   f. I don’t know

7. According to ECRI Institute and the FDA which of the following are considered fuels? Please choose all that apply.
   a. The patient
   b. Surgical drapes
   c. Alcohol based skin preparations
   d. Oxygen
   e. Electrocautery
   f. I don’t know

8. According to ECRI Institute guidelines, in the event of an airway fire what level of oxygen is recommended during ventilation until the airway fire is extinguished and residual airway devices removed from the airway?
   a. 15%
   b. 21%
   c. 35%
   d. 50%
   e. 75%
f. I don’t know

9. Do you feel competent in preventing and managing a surgical fire? (Do you think you possess both the knowledge and skills necessary to prevent and manage a surgical fire?)
   a. Yes, competent in both prevention and management of surgical fire
   b. Yes, competent in prevention, but not competent in management of surgical fire
   c. Yes, competent in management, but not competent in prevention of surgical fire
   d. No, not competent in management or prevention of surgical fire

10. During procedures that have high risk of surgical fire, will you incorporate surgical fire prevention strategies such as a fire risk assessment into your practice?
    a. Yes
    b. No

11. Was this presentation informative?
    a. Yes
    b. No
Appendix F

Surgical Fire Safety Follow up Post-Test

Follow up Post-Test

Please choose the best or most applicable answer for the following questions; unless indicated select only one answer.

1. The Fire Triangle consists of the following:
   a. Air, fuel, and combustion
   n. Air, triggers, and ignition source
   o. Oxygen, fuel, and ignition source
   p. Oxygen, fuel, and combustion
   q. I don’t know

2. What do ECRI Institute surgical fire safety guidelines recommend as the most effective tool for preventing surgical fires?
   a. Communication amongst the surgical team
   b. Avoiding use of polyvinyl chloride endotracheal tubes during surgeries of the head and neck
   c. Use of non-flammable surgical drapes
   d. Use of supplied oxygen concentration of less than 30% via nasal cannula or disposable face mask during surgeries of the head and neck
   e. I don’t know

3. According to ECRI Institute surgical fire safety guidelines, which of the following devices have the potential to ignite a fire in the operating room? Please choose all that apply.
   a. Laser
   b. Electrocautery/Electrosurgery
   c. Defibrillators
   d. Fiberoptic lights
   e. High speed burs
   f. I don’t know
4. According to ECRI and FDA surgical fire safety guidelines, which is appropriate for safe oxygen delivery during surgical procedures of the head, face, neck and upper chest?

Please choose all that apply.
   a. Use an open delivery oxygen system such as a nasal cannula combined with drape tenting to minimize oxygen buildup
   b. Use a closed system such as an endotracheal tube or laryngeal mask airway if greater than 30% oxygen is required
   c. Evaluate if supplemental oxygen is required by the patient
   d. Minimize oxygen accumulation with open draping techniques and insufflating air over the face where an airway device is not feasible
   e. I don’t know

5. According to the FDA, which of the following are recommended safety measures when using alcohol based skin preparations? Please choose all that apply.
   a. Allow adequate drying time as prescribed in the labeling for the specific product
   b. Drape the patient before the skin preparation solution is completely dry
   c. Prevent pooling of alcohol based skin preparation solutions
   d. Remove alcohol soaked materials from the prep area before draping
   e. Extend the drying time for hairy areas or skin folds where alcohol skin preparations are used
   f. I don’t know

6. According to ECRI Institute surgical fire safety guidelines, the anesthesia provider’s first priority in the event of a surgical fire on or around the patient is to:
   a. Notify the OR front desk
   b. Remove the tracheal tube
   c. Stop flow of gas
   d. Remove the ignition source
   e. Smother the fire
   f. I don’t know

7. According to ECRI Institute and the FDA which of the following are considered fuels? Please choose all that apply.
   a. The patient
   b. Surgical drapes
   c. Alcohol based skin preparations
   d. Oxygen
   e. Electrocautery
   f. I don’t know

8. According to ECRI Institute guidelines, in the event of an airway fire what level of oxygen is recommended during ventilation until the airway fire is extinguished and residual airway devices removed from the airway?
   a. 15%
b. 21%
c. 35%
d. 50%
e. 75%
f. I don’t know

9. During procedures that have high risk of surgical fire, have you altered your practice in any way?
   a. Yes
   b. No
9a. If yes, how?

9b. If not, why not?

   Comment:

10. Is a fire risk assessment completed during the surgical safety processes?

    a. Yes
    b. No
10a. If yes, how?

10b. If not, why not?

   Comment: