Use of A Decision Support Guide to Assist CRNAs in Preventing Surgical Fires: A Quality Improvement Project

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Abstract

Surgical fires are significant events that can result in severe injury or even death for patients and healthcare staff. Despite many initiatives led by the FDA, Anesthesia Patient Safety Foundation, and the American Association of Nurse Anesthetists, surgical fires still occur. The purpose of this quality improvement project was to assess anesthesia providers' perceptions of adequacy of a newly developed Perioperative Fire Prevention Guide. Implementation took place at a rural community hospital affiliated with a large academic medical center in a southeastern state. Two participants received a Qualtrics pre-intervention questionnaire, a newly developed Perioperative Fire Prevention Guide, and a presentation of the guide. The participants implemented the use of the guide into their practice over a two-week period. They then completed a Qualtrics post-implementation questionnaire that assessed their perceptions of the adequacy of the guide regarding completeness, accuracy, efficiency, and relevance to their practice. Overall, both participants were confident in their ability to identify high-risk procedures but less confident in their knowledge regarding case specific perioperative fire prevention strategies and felt an easily accessible reference guide would be supportive. The best way for healthcare systems to align with the initiative to decrease perioperative fires is to offer continuing education to staff, provide resource material that is efficiently obtained, implement policy regarding fire risk assessments, and integrate surgical fire prevention into educational simulation. Limitations of this project include small sample size (n=2), convenience sampling, and time constraints due to a busy work environment and limited staffing.

Keywords: CRNA, fire, prevention, guide

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Section I. Introduction

Background

Surgical fires are significant events that can result in severe injury or even death for patients and healthcare staff. For a surgical fire to occur, three factors encompassed within the fire triad must be present: an oxidizer, an ignition source, and a fuel source (Spruce, 2016). The component of the fire triad that Certified Registered Nurse Anesthetists (CRNAs) most directly affect is the oxidizer. Anesthesia professionals are the members of the surgical team who manipulate oxygen concentration and delivery methods. According to Eichhorn, Morell, & Greenberg (2020), most reported surgical fire incidences involve the utilization of open delivery of oxygen via nasal cannula or face mask during monitored anesthesia care (MAC). Fires become preventable events when each member of the surgical team knows their role in fire risk reduction. This begins with understanding the fire triangle, proper fire risk assessment tools, and methods of fire risk reduction (Spruce, 2016).

Despite many initiatives led by the Food and Drug Administration (FDA), Anesthesia Patient Safety Foundation (APSF), and the American Association of Nurse Anesthetists (AANA), surgical fires are still occurring throughout the nation (Kishiki et al., 2019). In October of 2011 the Food and Drug Administration (FDA) launched a surgical fire prevention initiative as part of the Safe Use Initiative. The launch of the initiative allows the FDA to establish partnerships with the appropriate stakeholders to identify risks and reduce harm caused with the use of certain medications and devices such as oxygen, skin preparation solutions, electrosurgical units, and lasers (Cowles et al., 2020). The collaborating partners involved in this initiative include the Nurse Anesthesia professional governing body, the American Association of Nurse Anesthesiology (AANA) and the Anesthesia Patient Safety Foundation (APSF). The mission of

the collaboration of these organizations and Surgical Fire Prevention Initiative is to increase awareness of factors that contribute to surgical fires, disseminate surgical fire prevention tools, and promote the adoption of risk reduction practices throughout the healthcare community (AANA, n.d.).

Organizational Needs Statement

Surgical fires are an area of concern for every anesthesia provider and healthcare organization providing surgical services because fire prevention in procedural areas is vital to the health and safety of organizations' employees and patients. According to the Joint Commission (n.d.), fire occurrences in procedural areas are classified as zero occurrence events.

The partnering organization for this quality improvement project was a rural community hospital affiliated with a large medical center located in a southeastern state. At this facility, in collaboration with anesthesiologists, CRNAs are the primary anesthesia provider and the surgical team member responsible for oxygenating the patient and administering combustible gases such as oxygen and nitrous. Because CRNAs provide these gases, they have the largest influence and control of the oxidizer component of the fire triad.

The majority of surgical patients receiving surgical care at this facility receive their anesthesia by way of MAC with open oxygen delivery. This method of anesthesia has been determined the most dangerous contributor to the occurrence of surgical fires (Cowles et al., 2020). Because of this, it is vital that the CRNAs at this establishment have continual education and decision support available to them in order to prevent these sentinel events from occurring.

Problem Statement

A hospital in a southeastern state provides the majority of their anesthesia under MAC using an open oxygen delivery method, which is deemed the most dangerous in regard to

surgical fire occurrence by anesthesia and safety specific governing bodies such as the APSF and AANA (AANA, n.d.; Cowles et al., 2020). Due to the high risk for surgical fire occurrence with MAC, there is an ongoing need for fire prevention strategy reinforcement and decision support for CRNAs managing MAC cases.

Purpose Statement

The purpose of this quality improvement project was to assess anesthesia providers' perceptions of adequacy of a newly developed Perioperative Fire Prevention Guide.

Section II. Evidence

A review of literature pertinent to surgical fire prevention and decision support for CRNAs providing open oxygen delivery during procedures requiring monitored anesthesia care was conducted using the electronic bibliographic databases PubMed Medline, Cumulative Index to Nursing & Allied Health Literature, ProQuest Search, and the search engine Google Scholar. Primary keywords and subject headings utilized included "operating rooms," "fires," "surgical fires," and "fire safety." See Appendix A for a list of subject headings and keywords applied by source. Limiters were applied based on availability within each source and included publication within the past five years (2015-2020), English language, and peer reviewed status. Specific search strategies, limiters, and the results are available in Appendix B. After de-duplication and review by title and abstract, 16 articles were identified as pertinent for full text review. Of the 16 articles reviewed, 6 were determined to contain evidence relevant to this project. See Appendix C for review of these articles within the Literature Matrix. Further literature was identified through linking, reference reviews, and searches of the websites of organizations such as the Joint Commission, APSF, and the AANA.

Current State of Knowledge

Using the Melnyk and Fineout-Overholt level of evidence model (2010), mostly systematic reviews of qualitative or descriptive studies (level V) and case-control or cohort studies (level VI) were identified as addressing surgical fires. There is a significant volume of level V evidence outlining the cause of surgical fires and broad fire prevention strategies. The highest levels of evidence available, I and II, are studies of newly developed fire prevention equipment, and fire prevention and response simulation training. Typically, information and recommendations regarding anesthesia's role in fire prevention and safe manipulation of the

oxidizer this is included within this broad evidence for fire prevention. Although there is limited specific evidence regarding how CRNAs can prevent fires, there are recommendations and guidelines from anesthesia specific and government agencies such as the AANA (n.d.), APSF (Cowles et al., 2020), Joint Commission (Castro, 2017), and the Council on Surgical and Perioperative Safety (CSPS, n.d.).

Current Approaches to Solving Population Problem

Current approaches to addressing the occurrence of surgical fires include a wide range of methods from development of oxygen concentration monitors and carbon dioxide emitting surgical devices (Gedebou, 2006; Samuels et al., 2019), virtual simulation training (Brunges & Hughes, 2020; Dorozhkin et al., 2017; Kishiki et al., 2019), and implementation of in-services or courses which include completion of educational modules or distribution of educational tools such as fire risk assessments and decision support guides (Fisher, 2015; Tola & Graling, 2018).

There are many tools and devices being studied and developed to prevent surgical fires, including an electrocautery oxygen sensor and a carbon dioxide emitting device. The oxygen sensor would be attached to the electrocautery device and detect the nearby oxygen concentration levels. If the oxygen concentration exceeded set thresholds the device would alarm and cut off power to the electrocautery device (Gedebou, 2006). Samuels et al. (2019) studied the effectiveness of a carbon dioxide emitting electrosurgical pencil. This tool was created by connecting a commercially available electrosurgical pencil with a smoke evacuation tip to a carbon dioxide insufflation system. A flame was ignited using porcine skin and differing concentrations of alcohol-based skin preparations. At just one-liter flow rates of carbon dioxide the flame was extinguished.

Kishiki et al. (2019) assessed the utility of simulation-based training with a single-blinded randomized control trial in which 82 participants were split into eight groups. Each group was given a surgeon and an anesthesia provider role. Groups were then assigned to either a simulation Group S or didactic Group D. Group S participated in two simulation training exercises, one prior to a classroom fire safety overview and one after. Group D participated in one simulation experience following the classroom fire safety overview. This study concluded that it took Group D three times as long to complete all tasks successfully compared to Group S, which highlighted the efficacy of simulation training over didactic training.

Tola and Graling (2018) conducted a quality improvement project implementing educational intervention with use of an evidence-based PowerPoint presentation and discussion focused on identification of high fire risk situations with the appropriate use of a fire risk assessment tool. They also reviewed fire prevention strategies and actions to take in the event a fire occurs. After the educational in-service, the participants were given the APSF fire safety algorithm to keep as a decision support guide. Fisher (2015) conducted a pilot study examining the efficacy of implementing a surgical fire prevention certification course for anesthesia providers. Ten participants completed a pre-test prior to an educational module, followed by a 50-question certification exam. A score of 85% and above was determined to indicate the anesthesia provider was competent in surgical fire prevention. The average pretest score was 66% suggesting the providers were not competent in surgical fire prevention. After completion of the educational module the posttest score mean was 92.8% percent. A paired samples t-test revealed a statistically significant increase in knowledge.

Evidence to Support the Intervention

This quality improvement project involved electronic distribution of a Perioperative Fire Prevention Guide to CRNAs that reinforces the fire triad, supports efficient and accurate identification of procedures involving high risk for fire occurrence, and outlines the CRNA role in decreasing fire risk through safe manipulation of open oxygen delivery methods. Although, the literature most strongly supports simulation training in fire occurrence prevention and response, electronic distribution of a fire safety and decision support guide to CRNAs was determined the best intervention in order to comply with existing COVID safety recommendations. These recommendations included avoidance of educational gatherings to maintain social distancing and distribution of printed materials that may increase transmission opportunity of the virus, as this project was completed during a worldwide pandemic.

Procedural areas of the hospital are very fast paced environments and CRNAs have many responsibilities to handle at once. It was decided, therefore, that a decision support guide that could be easily accessed on their mobile devices would provide the most efficient way to support CRNAs with fire prevention strategy reinforcement. According to Tola and Graling (2018), having increased knowledge of fire risk factors and having an identified role in fire risk reduction will reduce fire occurrence. Fisher's (2015) study suggests that providers do not receive sufficient surgical fire prevention education and that educational interventions are capable of increasing provider knowledge and competence. These measures are inexpensive, require limited time of the participant, and are recognized by professional organizations and accrediting bodies as best practice (Tola & Graling, 2018).

Evidence-Based Practice Framework

Identification of the Framework

The Neuman systems model (NSM) uses a systems approach to outline the human need of protection or relief from stress, in which healthcare providers can provide relief through identification and prevention of stressors (Neuman & Fawcett, 2011). Neuman's systems model is conceptualized visually as a ring structure. This model symbolizes the environment that contains potential stressors, in which the concentric rings represent protection from, and adaptation to, those stressors. These rings represent the patients' flexible line of defense, normal line of defense, and lines of resistance. Neuman's primary concept of prevention as intervention most directly applies to surgical fires. In this project, the model was applied to conceptualize how CRNAs can use primary prevention strategies to identify hazards and use their direct influence on the oxidizer component of the fire triad to prevent these zero occurrence events.

Primary prevention as the flexible line of defense includes CRNAs having the appropriate knowledge and education to identify surgical fire risk components in order to prevent unsafe combinations that may become a threat to the patient (Neuman & Fawcett, 2011). This includes preventing the use of oxygen concentrations above 21% when possible, as well as actively avoiding the creation of an oxygen enriched environment by preventing tenting. Secondary prevention as the normal line of defense begins once a fire occurs, but prior to causing harm to the patient. In this situation, CRNAs prevent harm to the patient by responding efficiently and knowing their role and responsibility in extinguishing the fire. Tertiary care as the lines of resistance comes into play if the surgical fire causes any harm to the patient. In this case, tertiary care would include returning the patient to the highest level of functioning possible and debriefing surgical staff on the occurrence of the fire and ways to prevent it in the future.

Ethical Consideration & Protection of Human subjects

This quality improvement project was deemed as exempt from full review through a process created in conjunction with the East Carolina University Institutional Review Board (IRB) and the partnering organization. See the approval form attached in Appendix D. Additionally, as the primary investigator, I completed the Collaborative Institutional Training Initiative (CITI) modules on research ethics and compliance in August of 2020, prior to beginning this project.

Considering this Doctor of Nursing Practice (DNP) project was focused on using current best practice guidelines to provide fire prevention strategies and decision support for CRNAs, and did not involve direct patient care, it involved no more than usual risk to the participants or the organization. Risks included provider frustration with the time required to review the virtual presentation of the Perioperative Fire Prevention Guide and having to access their phones or email during the shift or case.

Section III. Project Design

Project Site and Population

Implementation of this quality improvement project took place at a rural community hospital affiliated with a large academic medical center in a southeastern state. A facilitator of this project was the small site and project population, which allowed the project team to reach the entirety of the targeted population and obtain maximal participation among the CRNAs. Identified barriers included social contact limitations due to COVID, the fast-paced environment of the procedural areas, and potential lack of receptivity by potential participants to implementation.

Description of the Setting

The partnering organization has under 100 beds and surgical services are delivered with just three shared inpatient/ambulatory operating rooms and one endoscopy suite. The majority of surgical patients require only MAC because the hospital primarily provides minor surgical services that utilize regional anesthesia with sedation.

Description of the Population

The target population for project implementation were CRNAs who work in the procedural areas of the hospital. There are two full-time employed CRNAs on staff that were recruited as participants in this project. Both are experienced preceptors who commonly work with students in the perioperative areas.

Project Team

The team who implemented this quality improvement project was made up of a student registered nurse anesthetist (SRNA), a CRNA faculty member who served as the project chair and content specialist, a clinical CRNA faculty member who acted as liaison with the study

setting and recruited participants, and the Nurse Anesthesia program director. An additional non-CRNA faculty member coordinated project development and implementation and an onsite clinical manager provided support in the clinical setting. Initial development of the project was accomplished in cooperation with three additional students addressing the same clinical topic. The primary SRNA independently implemented the Perioperative Fire Prevention Guide, administered the surveys assessing participant perceptions, and analyzed the survey data.

Project Goals and Outcome Measures

The goal of this quality improvement project was to assess anesthesia providers' perceptions of adequacy of a newly developed Perioperative Fire Prevention Guide.

Description of the Methods and Measurement

This project used a pre- and post-survey design to perform a single Plan Do Study Act (PDSA) cycle (Langley et al., 2009). The Perioperative Fire Prevention Guide was created with the graphic design application Canva. Using Prezi, a presentation of the guide with voice over was created to describe the guide to the project participants. Participants were recruited by the clinical liaison. Upon initiation of the project, an email including a link to the Qualtrics pre-intervention questionnaire, the Perioperative Fire Prevention Guide in PDF format, and the presentation including instructions and next steps was sent to each participant. After a two-week implementation period the post-intervention survey was emailed to participants. Data was then measured from the post-intervention survey responses.

Discussion of the Data Collection Process

As noted, data was collected electronically using a pre- and post- intervention survey designed using Qualtrics survey software. An anonymous link and completion instructions were emailed to each participant prior to and after the implementation period. The surveys were

designed using Likert scale, dichotomous, and open-ended questions. Results were then transferred to Excel for analysis. See Appendix E for the pre- and post-intervention questionnaires.

Implementation Plan

As noted previously, the implementation of this quality improvement project began with electronic distribution, via email, of an anonymous link to the Qualtrics pre-intervention questionnaire, the Perioperative Fire Prevention Guide in PDF format, and the presentation of the guide including instructions and next steps. The CRNAs then implemented the Perioperative Fire Prevention Guide into their practice over a two-week period in June of 2021. Following the implementation period, the CRNAs received and were asked to complete an anonymous Qualtrics post-implementation questionnaire that assessed their perceptions of the adequacy of the reference guide in regard to completeness, accuracy, efficiency, and relevance to their practice. See Appendix F for the Perioperative Fire Prevention Guide.

Timeline

A timeline of project activities is available in Appendix G. This project topic was assigned by the program director in May of 2019 upon entry into the CRNA program DNP foundation courses. Early knowledge of the project topic provided opportunity to build familiarity with the literature between August of 2019 and October of 2020, when literature searches were completed. This project received approval through a special process for quality improvement projects through the organization and University and Medical Center IRB (UMCIRB) in March 2021. See the approval form attached in Appendix D. Development of the Perioperative Fire Prevention Guide and pre- and post-intervention Qualtrics surveys began in October of 2020 and development was finalized in March of 2021. The intervention video

outlining the guide and explaining the project implementation process to participants was developed and finalized in March 2021. The project launch and gathering of data occurred in June of 2021 and data analysis was completed in July of 2021.

Section IV. Results and Findings

Results

As outlined in prior sections, data was collected over a two-week period. The goal was to assess anesthesia providers' perceptions of adequacy of a newly developed Perioperative Fire Prevention Guide. The pre- and post- intervention surveys focused on determining the providers confidence level in their knowledge and decision making regarding perioperative fire risk identification and prevention, if the developed guide adequately reviewed necessary perioperative fire prevention strategies for specific case types, and if the guide was efficiently obtained and useful. The surveys were completed by the two recruited participants who overall felt the Perioperative Fire Prevention Guide was useful and easy to access.

Analysis

Upon review of the pre-intervention survey data, it was found that both participants had received initial and continuing education regarding perioperative fire prevention and had access to a perioperative fire prevention resource that would take one participant 1-3 minutes to obtain and the other 4-6 minutes. Neither participant has experienced a perioperative fire, but both have managed procedures where all the fire triad elements were present. Overall, both participants felt they were confident in their ability to identify a high-risk procedure but were less confident in their knowledge regarding perioperative fire prevention. Both participants selected that an easily accessible reference guide would be supportive in decision making regarding fire prevention in the perioperative period.

Upon review of the post-intervention data, within the two-week data collection process, both participants experienced between 0-2 high fire risk procedures. Both participants felt that the reference material was easily accessible and saved them time by requiring only 1-3 minutes to obtain, and felt the guide was visually appealing. Regarding their perception of usefulness of

the guide, one participant felt it would be very useful for the anesthesia department while the other selected neutral. Despite this, both CRNAs selected that they were very confident in their knowledge regarding perioperative fire prevention and both CRNAs selected that they will use this reference guide in their practice.

As shown in Figure 1, the CRNAs' confidence in their knowledge of perioperative fire prevention improved. Additionally, this project provided them with reference material they reported as taking less time to access, as shown in Figure 2.

Figure 1

Confidence in Knowledge Pre- and Post- Intervention Comparison (N=2)

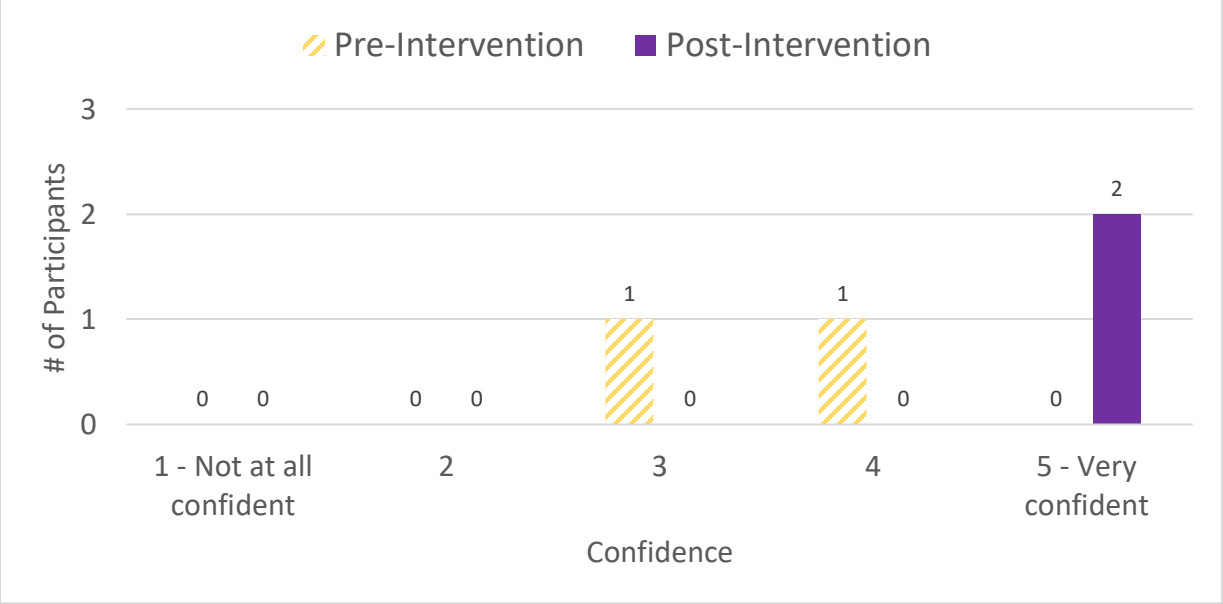
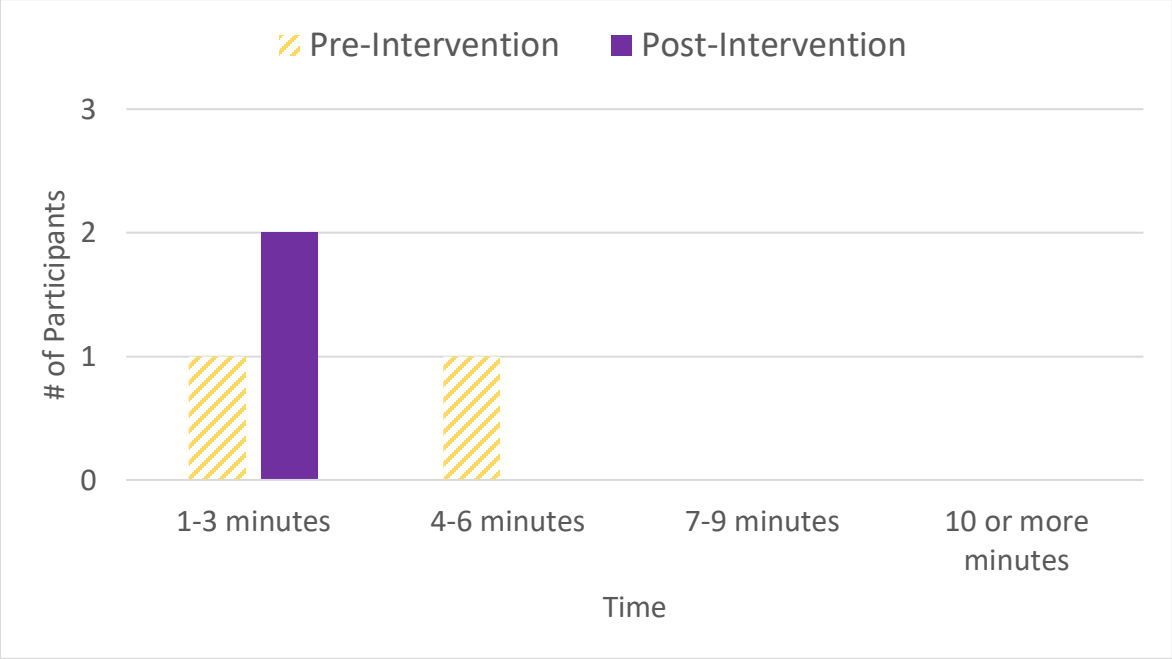


Figure 2

Length of Time to Access Reference Material Pre- and Post- Intervention (N=2)



Section V. Interpretation and Implications

Cost Benefit Analysis

The costs of this project would entail the cost of the application required to create the graphic, Canva, which is $12.00, and the cost of employee time for creating the deliverables. The time required to create the deliverables in total was around twelve hours, which would cost the organization between $900.00 and $1,500.00, depending on the pay rate for the employee creating it. Considering the information was provided via email, there was no cost accrued for the instruction portion of the project or printed material because no team meeting or gathering were required and the information could be reviewed electronically during time already on the clock.

The greatest potential benefit of instituting the intervention of focus in this project was reducing the risk of perioperative fires, which may result in reduction of morbidity and mortality among both patients and staff. On average, the cost of a patient injury claim from a surgical fire ranges from $120,000 to $30 million dollars (Mehta et al., 2013). Depending on the size of the fire, it could damage costly operating room equipment or injure or kill staff, which would be devastating, financially costly, and result in decreased ability to deliver reimbursable patient care. It is important to also consider the cost of diminishing the reputation and trust in the organization which can decrease business and indirectly decrease profits. In comparison, if even one patient injury claim is prevented, the organizations return on investment is almost a 12,000% increase.

Resource Management

Nonfinancial resources of the organization that contributed to the successful performance of this project included a reliable organizational email system that allowed secure contact between the primary investigator and participants, as well as software compatible with the shared

files. For the design of this project, the resources that were necessary for complete and accurate implementation were available and no other resources were necessary.

The participants and other OR staff showed positive attitudes towards project implementation. Once the OR staff expressed interest in participating in the project to one of the participants, they emailed the guide to the entire OR staff and the fire risk assessment was performed and stated during timeouts to ensure every member of the team was aware of fire risk. The OR staff showing such interest in the project revealed an opportunity of including other team members in future projects.

Implications of Findings

Recall that Neuman's systems model uses a systems approach to outline the human need of protection or relief from stress, in which healthcare providers are able to provide relief through identification and prevention of stressors (Neuman & Fawcett, 2011). The model was applied to conceptualize how CRNAs can use primary prevention strategies to identify hazards and use their direct influence on perioperative fire prevention to prevent these zero occurrence events. The findings of this project suggest that continual education would increase provider knowledge, which would allow them to adequately identify and prevent stressors that cause harm to patients.

The FDA and AANA have collaborated to create an initiative to decrease perioperative fire occurrence. This initiative was launched with the goals of increasing awareness of the fire triad elements, distributing perioperative fire prevention reference material, and promoting the use of risk reduction strategies throughout healthcare organizations (AANA, n.d.). Using a single PDSA cycle, this project aligned with their initiative by providing continual education on the fire triad, fire risk assessment and identification, perioperative fire prevention strategy and risk

mitigation on a distributable, easily accessible guide. The findings of this project revealed provider openness to further education on the topic of perioperative fire prevention, supported the assumption that continual education would increase provider knowledge, and revealed that CRNAs find value in reference material that is efficiently accessible. To align with this initiative more closely, a suggestion for further implementation would be to include fire extinguishing strategies for fire occurrence in each specific case type.

Implications for Patients

Increasing provider knowledge and experience in perioperative fire prevention will indirectly increase patient safety by decreasing the potential for fire events that may result in injury or death to patients.

Implications for Nursing Practice

One of the major ethical foundations of nursing, patient advocacy, goes hand in hand with patient safety. To keep patients safe during the perioperative period it is imperative that CRNAs are aware of the risk factors for fire occurrence in procedural areas and are educated on prevention strategies for each specific case type that carries higher risk for fire occurrence. This project found that although CRNAs have had education regarding perioperative fire prevention they were more confident in their abilities to prevent fire occurrence after continued education.

To accomplish change and improve practice, it is best if both administrators as well as employees providing direct care, are flexible in mindset and allow evidence-based data to influence change the culture of practice. According to the APSF, it is imperative to remain engaged and involved with professional organizations, standards groups, accreditors, and certification boards to ensure that perioperative fire prevention remain a top priority with emphasis on increasing knowledge (Cowles et al., 2020).

Implications for Healthcare System

Based on available literature, the best way for healthcare systems to align with the initiative to decrease perioperative fires is to offer continuing education to staff, provide resource material that is efficiently obtained (Fisher, 2015; Tola & Graling, 2018), implement policy regarding fire risk assessments, and integrate surgical fire prevention into educational simulation centers (Brunges & Hughes, 2020; Dorozhkin et al., 2017; Kishiki et al., 2019). Fire prevention requires no additional cost to the organization and is 100% effective in decreasing morbidity and mortality of the patients and communities they serve (Cowles et al., 2020).

Sustainability

The organization can afford to continue the distribution of this Perioperative Fire Prevention Guide due to the low cost and large benefit ratio; distribution of the guide did not require the purchase of new equipment or supplies and requires minimal time and practice adjustments from employees. To fully encompass the initiative of the FDA, AANA, APSF, and ANA, further quality improvement projects need to be implemented to address fire extinguishing strategies for specific case types, implementation of projects that involve and educate all OR staff and their roles in perioperative fire prevention.

Dissemination Plan

Dissemination of this project included a written paper that will be posted in The ScholarShip, which is East Carolina's electronic material repository, for review. A project poster was created and presented in person and virtually via Zoom with other students, program faculty, and project participants invited to attend.

Section VI. Conclusion

Limitations

Limitations of this project include the small sample size (n=2), convenience sampling, and time constraints due to a busy work environment and limited staffing.

Recommendations for Others

If this project was to be duplicated or continued, the primary investigator would recommend including how to extinguish a fire for specific case types within the reference material and involve the entire operating room staff in the education process considering safety of the patient and fire risk reduction is a team effort.

Recommendations for Further Study

Recommendations for further study regarding perioperative fire prevention could include the use of simulation experiences with the entire OR staff. A Perioperative Fire Prevention Guide that includes fire extinguishing strategies could be incorporated into Epic as an information sheet to make it easily accessible without the use of a personal electronic device. Further study could also involve the analysis and editing of pre-existing fire prevention policies. A project could also be implemented to develop a continuing education course or module regarding perioperative fire prevention that is included in employees' yearly module training.

References

American Association of Nurse Anesthetists. (n.d.). *Surgical fires.* Retrieved August 27, 2020, from https://www.aana.com/practice/clinical-practice-resources/surgical-firesb

Brunges, M., & Hughes, T. E. (2020). Using virtual human technology in perioperative team training simulations: The official voice of perioperative nursing. *AORN Journal, 111*(6), 617-626. https://dx.doi.org/10.1002/aorn.13046

Castro, G. M. (2017, October 12). *Only you can prevent surgical fires*. The Joint Commission. https://www.jointcommission.org/resources/news-and-multimedia/blogs/leading-hospital-improvement/2017/10/only-you-can-prevent-surgical-fires/

Council on Surgical and Perioperative Safety (n.d.). *#7 fire safety.* http://www.cspsteam.org/7-fire-safety

Cowles, C., Lake, C., & Ehrenwerth, J. (2020). Surgical fire prevention: A review. *APSF Newsletter, 35*(3). https://www.apsf.org/article/surgical-fire-prevention-a-review/

Dorozhkin, D., Olasky, J., Jones, D. B., Schwaitzberg, S. D., Jones, S. B., Cao, C., Molina, M., Henriques, S., Wang, J., Flinn, J., De, S., & Sages Fuse Committee (2017). OR fire virtual training simulator: Design and face validity. *Surgical Endoscopy, 31*(9), 3527–3533. https://doi.org/10.1007/s00464-016-5379-7

Fisher, M. (2015). Prevention of surgical fires: A certification course for healthcare providers. *AANA Journal, 83*(4), 271-274, 234.

Gedebou, T. (2006). *Oxygen sensory system that minimizes outbreak of operating room fires* (U.S Patent No. 10/940,330). U.S. Patent and Trademark Office. https://patentimages.storage.googleapis.com/8e/d5/94/a4db1b35160f6f/US20060058784A1.pdf

Kishiki, T., Su, B., Johnson, B., Lapin, B., Kuchta, K., Sherman, L., Carbray, J., & Ujiki, M. (2019). Simulation training results in improvement of the management of operating room fires- a single-blinded randomized controlled trial. *The American Journal of Surgery, 218*(2), 237-242. https://doi.org/10.1016/j.amjsurg.2019.02.035

Langley, G. L., Moen, R., Nolan, K. M., Nolan, T. W., Norman, C. L., & Provost, L. P. (2009). *The Improvement Guide: A Practical Approach to Enhancing Organizational Performance* (2nd edition). Jossey-Bass.

Mehta, S. P., Bhananker, S. M., Posner, K. L., & Domino, K. B. (2013). Operating room fires: A closed claims analysis. *Anesthesiology, 118*(5), 1133-1139. https://doi.org/10.1097/ALN.0b013e31828afa7b

Neuman, B. M., & Fawcett, J. (2011). *The Neuman systems model* (5th ed.). Pearson.

Samuels, J. M., Carmichael, H., Wikiel, K. J., Robinson, T. N., Barnett, C. C., Jones, T. S., & Jones, E. L. (2019). Carbon dioxide can eliminate operating room fires from alcohol-based surgical skin preps. *Surgical Endoscopy, 34*(4), 1863-1867. https://doi.org/10.1007/s00464-019-06939-z

Spruce, L. (2016). Back to basics: Preventing surgical fires. *AORN Journal, 104*(3), 217-224. https://doi.org/10.1016/j.aorn.2016.07.002

Stillwell, S. B., Fineout-Overholt, E., Melnyk, B. M., & Williamson, K. M. (2010). Evidence-based practice step by step: Searching for the evidence. *The American Journal of Nursing, 110*(5), 41-47. https://doi.org/10.1097/01.NAJ.0000372071.24134.7e

The Joint Commission. (n.d.). *Sentinel event alert 29: Preventing surgical fires.* https://www.jointcommission.org/resources/patient-safety-topics/sentinel-event/sentinel-event-alert-newsletters/sentinel-event-alert-issue-29-preventing-surgical-fires/

Tola, D. H., Jillson, I. A., & Graling, P. (2018). Surgical fire safety: An ambulatory surgical center quality improvement project: The official voice of perioperative nursing. *AORN Journal, 107*(3), 335-344. doi: http://dx.doi.org/10.1002/aorn.12081

Appendix A

Keywords and Subject Headings Used for Literature Searches

	Concept	
	Location	Fire
Keywords	Operating room Surgical	Fire Fires Flame
PubMed MeSH	"Operating rooms"	"Fires"
CINAHL Subject Headings	"Surgical fires" "Fire safety"	

Appendix B

Literature Search Log

Search Date	Database/Search Engine	Search Strategy	Limits Applied	Number of Results	Number Kept
10/16/2020	PubMed	(Operating rooms) AND (fires)	2015-2020	71	13
10/16/2020	CINAHL	(MH "Surgical Fires/PC")	2015-2020 Full text Academic Journal	8	1
10/16/2020	ProQuest Search	((surgical) OR (operating room)) AND ((fire) AND (oxidizer) AND (prevention))	2015-2020 Peer reviewed Scholarly Journal English	2,673 Reviewed first 50 results	2
10/16/2020	Google Scholar	(monitored anesthesia care) AND (fire) AND (prevention) AND (anesthetist)	2015-2020	2,550 Reviewed first 5 pages	0

Appendix C

Literature Matrix

APA Citation	Level of Evidence	Description	Conclusion Use of Evidence
Coletto, K., Tariman, J. D., Lee, Y., & Kapanke, K. (2018). Perceived knowledge and attitudes of certified registered nurse anesthetists and student registered nurse anesthetists on fire risk assessment during time-out in the operating room. *AANA Journal, 86*(2), 99-108.	VI	Using a descriptive cross sectional design the attitudes of CRNAs and SRNAs regarding fire risk assessment during time-outs were examined. Knowledge and attitude questionnaires were sent to 1,600 active members of a state association of nurse anesthetists via an online survey. 140 people participated.	There is a self-reported knowledge deficit in regard to fire safety and prevention among CRNAs and SRNAs
Cowles, C., Lake, C., & Ehrenwerth, J. (2020). *Surgical fire prevention: A review*. Anesthesia Patient Safety Foundation.	VII	A review by the APSF regarding surgical fire risk and prevention techniques. The APSF reviews the importance of educating surgical staff about fire prevention safety which should include fire risk assessment, communication among staff, safe use of oxidizers, and ignition and fuel sources.	Continual education and the knowledge of risks and management of operating room fires need continuous attention. Fire prevention requires zero additional cost and approaches 100% effectiveness.
Fisher, M. (2015). Prevention of surgical fires: A certification course for healthcare providers. *AANA Journal, 83*(4), 271-274, 234.	QI	A QI project with a sample of 7 CRNAs and 3 anesthesiologists were given a course manual written by the program developer, and a two-hour course which included a visual presentation on the fire triad, provider responsibility for these elements, high risk procedures, team situational awareness, goal directed tasks, and case studies. The participants were then given a 50-question multiple choice exam based on chapter objectives and case studies.	This study suggests that providers do not receive sufficient surgical fire prevention and that educational interventions are capable of increasing provider knowledge and competence.

Samuels, J. M., Carmichael, H., Wikiel, K. J., Robinson, T. N., Barnett, C. C., Jones, T. S., & Jones, E. L. (2019). Carbon dioxide can eliminate operating room fires from alcohol-based surgical skin preps. *Surgical Endoscopy, 34*(4), 1863-1867.	III	Using a 15x15 section of clipped porcine skin and surgical preps containing differing concentrations of alcohol, fire was ignited using an electrosurgical pencil with an attached smoke evacuation tip that was connected to a laparoscopic CO2 insufflation system. Flame was ignited by activating the electrosurgical pencil immediately after alcohol prep application. CO2 was then infused through the smoke evacuation pencil from 0-8L/min.	It was determined that the carbon dioxide emitting device eliminated fire formation at a flow rate of just 1L/min.
Spruce, L. (2016). Back to basics: Preventing surgical fires. *AORN Journal, 104*(3), 217-224.	VII	Provides the basics of surgical fire prevention including proper fire risk assessment, guidelines regarding supplemental oxygen use, proper use of alcohol-based skin antiseptics and surgical equipment, how to properly communicate with the surgical team, how to control ignition sources, oxidizers, and fuels, and lastly provides strategies for success.	Understanding what causes fires, how to prevent them and how to respond if one occurs is crucial. All team members play an important role in preventing fires and a well-educated surgical team can prevent surgical fires from occurring
Tola, D. H., Jillson, I. A., & Graling, P. (2018). Surgical fire safety: An ambulatory surgical center quality improvement project: The official voice of perioperative nursing. *AORN Journal, 107*(3), 335-344.	QI	A QI Project consisting of an educational intervention with pre and post assessment of knowledge, attitude, and practice regarding fire safety. Participation was below 25% with 14 individuals completing follow up surveys. Some improvement in fire prevention knowledge and prevention practice was identified through post survey responses.	Brief educational intervention regarding fire risk assessment contributes to improving staff member knowledge and use of prevention strategies

Note. Levels of Evidence from "Evidence-based practice step by step: Searching for the evidence," by S. B. Stillwell, E. Fineout-Overholt, B. M. Melnyk, & K. M. Williamson, 2010, *The American Journal of Nursing, 110*(5), 41-47. Copyright 2010 by Wolters Kluwer Health.

Appendix D

Organization Approval Form

Center for Research & Grants

Quality Assurance/Quality Improvement Project vs. Human Research Study (Requiring IRB approval) Determination Form

This worksheet is a guide to help the submitter to determine if a project or study is a quality assurance/quality improvement (QA/QI) project or research study and is involving human subjects or their individually identifiable information and requires IRB approval as defined by the Health and Human Services (HHS) or Food and Drug Administration (FDA). Once completed, please email the form to A CRG team member will contact you with the results of their review and may request additional information to assist with their determination. The determination will be made in conjunction with the office.

Please contact CRG with any questions at

For more guidance about whether the activity meets the definition of Human Subjects Research see

Project Title: Assessing anesthesia providers' perceptions of adequacy of operating room fire prevention		
Funding Source: None		
Project Leader Name: Erin Brackett/Dr. Angela Ciuca	☐ Ed.D. ☐ J.D. ☐ M.D. ☐ Ph.D. ☐ Pharm.D. ☒ R.N. ☐ Other(specify):	
Job Title: ECU SRNA/ECU CRNA Faculty	**Phone:**	**Email:**
	Primary Contact (if different from Project Leader): Erin Brackett, SRNA	
		Email:

Key Personnel/ Project Team members:

Name and Degree:	Department: (Affiliation if other than Vidant)	Email:
Erin Brackett, SRNA	ECU Nurse Anesthesia Program	
Dr. Ciuca, DNAP, CRNA	ECU Nurse Anesthesia Program	
Dr. McAuliffe, PhD, CRNA	ECU Nurse Anesthesia Program	

QI/QA Assessment Checklist:

Consideration	Question	Yes	No
PURPOSE	Is the PRIMARY purpose of the project/study to: • IMPROVE care right now for the next patient? OR • IMPROVE operations outcomes, efficiency, cost, patient/staff satisfaction, etc.?	✔	☐
RATIONALE 1	The project/study falls under well-accepted care practices/guidelines or is there sufficient evidence for this mode or approach to support implementing this activity or to create practice change, based on: • literature • consensus statements, or consensus among clinician team	✔	☐
RATIONALE 2	The project/study would be carried out even if there was no possibility of publication in a journal or presentation at an academic meeting. (**Please note that answering "Yes" to this statement does not preclude publication of a quality activity.)	✔	☐
METHODS 1	Are the proposed methods flexible and customizable, and do they incorporate rapid evaluation, feedback and incremental changes?	✔	☐
METHODS 2	Are patients/subjects randomized into different intervention groups in order to enhance confidence in differences that might be obscured by nonrandom selection? (Control group, Randomization, Fixed protocol Methods)	☐	✔
METHODS 3	Will there be delayed or ineffective feedback of data from monitoring the implementation of changes? (For example to avoid biasing the interpretation of data)	☐	✔
METHODS 4	Is the Protocol fixed with fixed goal, methodology, population, and time period?	☐	✔
RISK	The project/study involves no more than minimal risk procedures meaning the probability and magnitude of harm or discomfort anticipated are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.	✔	☐
PARTICIPANTS	Will the project/study only involve patients/subjects who are ordinarily seen, cared for, or work in the setting where the activity will take place?	✔	☐
FUNDING	Is the project/study funded by any of the following? • An outside organization with an interest in the results • A manufacturer with an interest in the outcome of the project relevant to its products • A non-profit foundation that typically funds research, or by internal research accounts	☐	✔

If all of the check marks are inside the shaded grey boxes, then the project/study is very likely QI and not human subject research. Projects that are not human subject research do not need review by the IRB.

In order to assess whether your project meets the definition of human subject research requiring IRB review or may qualify as a quality improvement/assurance activity, please provide the following information:

1. Project or Study Summary:
   As a separate attachment, please provide a summary of the purpose and procedures as well address all of the following:
   a) The project question/hypothesis.
   b) The project design.
   c) Any interaction or intervention with humans.
   d) A description of the methods that will be used and if they are standard or untested.
   e) Specify where the data will come from and your methods for obtaining this data -please specify who/where (i.e. CRG will provide you with the data, or someone from a specific department will provide you with the data, or you will pull it yourself).
   f) Specify what data will be used and any dates associated with when that data was originally collected (i.e Patient Name, Diagnosis, Age, Sex). *If applicable, please attach your data collection sheet.*
   g) Where will the data (paper and electronic) for your project be stored? Please specify how it will be secured to protect privacy and maintain confidentiality. For paper data, please provide physical location such as building name and room number and that it will be kept behind double lock and key. For electronic data, please provide the file path and folder name network drive where data will be stored and specify that it is secure/encrypted/password protected. If using other storage location, please provide specific details.
   h) Please specify how long data will be stored after the study is complete? (Keep in mind that data collected/generated during the course of the project that includes protected health information (PHI) should have identifiers removed at the earliest opportunity.)
   i) Please specify how the collected data will be used (internal/external reports, publishing, poster, etc.).

   Please attach a summary and/or any other additional documentation describing your project

2. If the Primary purpose of your project/study is for QA/QI, have you obtained approval from the operational leader within your department or health system:
   ☒ **Yes** [Please specify here whom and obtain their signature in the signature section below]:
   ☐ **No** [Contact the appropriate operational leader for approval.]

Please note:

- By submitting your proposed project/study for QA/QI determination you are certifying that if the project/study is established to qualify as QA/QI project, you and your Department would be comfortable with the following statement in any publications regarding this project: "This project was reviewed and determined to qualify as quality improvement by the for Research and Grants."
- If you are submitting a Poster to Media Services for printing, you will need to also submit this Quality Improvement Worksheet or proof of your IRB Application and IRB Approval.
- If the determines the activity is not human subject research, then any presentation, publication, etc. should not refer to the activity as "human subject research," "exempt research," or "expedited research."
- If you would like the to verify that a project/study is not human subject research, please provide this form completed with the summary of your activity and any additional information to the at and the following will be completed and returned to you for your records.

NHSR vs. HSR Determination:

☒ **Not Human Subject Research:** The has determined that based on the description of the project/study, approval by the IRB is not necessary. Any changes or modifications to this project may be discussed with the at that time to ensure those changes do not elevate the project to human research that would need IRB approval.

☐ **Human Subject Research:** This project/study requires review by the IRB prior to initiation. An application in the electronic IRB submission system should be submitted.

Approval Signatures:

Department (Site) Manager: _____ **Date:** 2/24/21

Reviewer: _____ **Date:** _____

UMCIRB Office Staff Reviewer: **Date:** 3-10-21

Appendix E

Pre- and Post- Intervention Questionnaires

Pre-intervention Questionnaire

1. Have you **ever** received education on perioperative fire prevention?
   Yes/No
2. Have you received continuing education on perioperative fire prevention?
   Yes/No
3. How confident are you in your knowledge about perioperative fire prevention?
   Not at all confident 1 2 3 4 5 Very confident
4. Have you participated in a procedure where all the elements of the fire triad were present?
   Yes/No
5. Have you ever experienced a perioperative fire?
   Yes/No
6. How confident are you in your ability to identify a surgical procedure that has a high risk of fire?
   Not at all confident 1 2 3 4 5 Very confident
7. Do you currently have perioperative fire prevention guidelines that you can quickly access while at work?
   Yes/No
8. If you had a question about perioperative fire prevention, approximately how long do you think it would take you to find reference material to answer the question?
   1-3 minutes 4-6 minutes 7-9 minutes More than 10 minutes
9. Would an easily accessible reference guide provide you support in decision making regarding high fire risk procedures?
   Yes/No

Post-intervention Questionnaire

1. Approximately how many procedures did you participate in over the last two weeks that qualified as high-risk for fire?
   0-2 3-5 6-8 More than 8 procedures
2. What is your perception of the usefulness of this reference guide for an anesthesia department?
   Not at all useful 1 2 3 4 5 Very useful
3. Was this reference guide easily accessible in the clinical setting?
   Yes/No
4. Did you find this reference guide visually appealing?
   Yes/No
5. Did this reference guide save you time?
   Yes/No
6. If saved to your mobile phone or work computer, how long would it take you to access this reference guide?
   1-3 minutes 4-6 minutes 7-9 minutes More than 10 minutes
7. Do you think you will use this reference guide in your practice as a CRNA?
   Yes/No
8. After reviewing this reference material, how confident are you in your knowledge about perioperative fire prevention?
   Not at all confident 1 2 3 4 5 Very confident
9. Do you have any recommendations to improve the reference guide? (i.e., is there something missing).
   Open ended response

Appendix F

Perioperative Fire Prevention Guide

ECU

Case Specific Tips

Monitored Anesthesia Care

- Avoid supplemental O_2[6,7,8]
- Do not deliver 100% FiO_2[6,8]
- Use O_2 blender or CGO to deliver O_2 ≤ 30%[6,8]
- Consider ETT/LMA in high-risk cases requiring ≥ 30% FiO_2[6,8]
- Position drapes and forced air warming equipment to prevent tenting and trapping of O_2[8,9]
- Suction the zone around the head to limit O_2 and N_2O gases in the area[9]

Head and Neck Surgery

- Scavenge oropharynx with suction during oral cases[9]
- Discuss O_2 delivery with surgeon during case[10]
- Ask the surgeon to announce intent to use an ignition source[10]
- Saline available if surgery in oral cavity[10]

Airway and Lung Surgery

- Stop N_2O, decrease O_2 to ≤30% for 1-5 minutes before activating ignition source in airway[9]
- Ensure no air leak from ETT[3]
- Consider suctioning ipsilateral lumen of DLT to decrease O_2 near electrocautery[3]

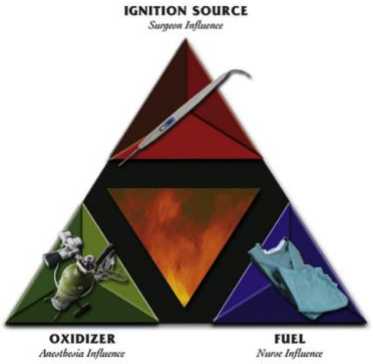
Laser Surgery/ENT

- Use appropriate laser resistant ETT[9]
- Fill ETT cuff with saline and indicator dye[9]

Other

- Check anesthesia circuit for leaks[5]
- Ensure O_2 off after every case[5]

Surgical Fires



Anesthesia is primarily responsible for managing the oxidizer component of the fire triad (O_2 and N_2O)[1]

O_2 was the oxidizer in 95% of electrocautery-induced OR fires and 100% of fires with other ignition sources[2]

Standard ETT is combustive when O_2 >25%[3]

Silverstein Fire Risk Assessment[4]

Score one point for each item below	
Open oxygen source	
Presence of an ignition source	
Surgery at/above the xiphoid	
	Total _____

Scoring

0-1: Low risk

2: Intermediate risk

3: High risk

Communicate fire risk with all staff[5]

[1]Ahmed OI, Girshin M. Fire safety in the operating room. *APSF.* 2013; 28(1):17. [2]Mehta SP, Bhananker SM, Posner KL, Domino KB. Operating room fires: A closed claim analysis. *Anesthesiology.* 2013; 118(5): 1133-1139. [3]Bansal A, Bhama JK, Varga JM, Toyoda Y. Airway fire during double-lung transplantation. *Interact Cardiovasc Thorac Surg.* 2013; 17(6):1059-1060. [4]Mathias JM. (2006). Scoring fire risk for surgical patients. *OR Mgr.* 2006; 22(1): 1-3. [5]Spruce L. Back to basics: Preventing surgical fires. *AORN J.* 2016; 104(3): 217-224.e2. [6]Jones TS, Black IH, Robinson TN, Jones EL. Operating room fires. *Anesthesiology.* 2019; 130(3): 492-501. [7] (2003). Sentinel event alert: Preventing surgical fires. The Joint Commission. https://www.jointcommission.org/-/media/tjc/documents/resources/patient-safety-topics/sentinel-event/sea_29.pdf. Published 2003. Accessed November 3, 2020. [8]USFDA. Recommendations to reduce surgical fires and related patient injury: FDA safety communication. https://www.fda.gov/medical-devices/safety-communications/recommendations-reduce-surgical-fires-and-related-patient-injury-fda-safety-communication. Published 2018. Accessed November 3, 2020. [9]ASA. Practice advisory for the prevention and management of operating room fires: An updated report by the ASA task force on operating room fires. *Anesthesiology.* 2013; 118(2):1-20. [10]Di Pasquale L, Ferneini EM. Fire Safety for the Oral and Maxillofacial Surgeon and Surgical Staff. *Oral Maxillofac Surg Clin North Am.* 2017; 29(2): 179-187.

Appendix G

DNP Project Timeline

May 2019	Receive topic
May 2020	Explore project background; define topic
Aug 2019 – Oct 2020	Literature review
Oct 2020 – Mar 2021	Perioperative Fire Prevention Guide created
Oct 2020 – Mar 2021	Qualtrics surveys developed
March 2021	UMCIRB approval
March 2021	Guide presentation created
June 2021	Project implementation
June 2021	Data collection
June 2021	Data analysis