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

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Fire risk assessment remains separate from the universal protocol for surgical time-outs. A descriptive cross-sectional design was used to examine the perceived knowledge and attitudes of Certified Registered Nurse Anesthetists (CRNAs) and student registered nurse anesthetists (SRNAs) on fire risk assessment during surgical time-outs. Modified knowledge and attitudes questionnaires were sent to approximately 1,600 active members of the Illinois Association of Nurse Anesthetists through an online survey. Data were analyzed using descriptive, t-test, analysis of variance, and point biserial correlation statistics.

Most of the 140 study participants overwhelmingly reported positive attitudes toward fire risk assessment, but they had self-reported information needs in 11 areas of the operating room fire risk assessment questionnaire. Age, gender, years in practice, and highest education had no statistically significant correlation with knowledge and attitudes regarding fire risk assessment. The perceived knowledge deficits on fire risk assessment may hinder the CRNAs and SRNAs from adopting a tool such as a fire risk assessment checklist that is ready for implementation at their current place of employment. Additional studies are needed to identify the factors that facilitate integration of fire risk assessment using a checklist during surgical time-outs.

Keywords: Anesthesia providers, fire, operating room, safety, surgical time-outs.

Fires in the operating room (OR) are extremely rare but could be fatal.[1] The estimated incidence of OR fires is 0.32 per 100,000 operations.[2] A death or disability resulting from a burn incurred in the OR is a serious and costly event, which has been included in the Centers for Medicare and Medicaid Services' (CMS) category of "never events". CMS defined *never events* as clearly identifiable and highly preventable events that are deemed to be nonreimbursable, serious, hospital-acquired conditions.[3] Because the consequences of a fire in the OR are dire, it is crucial to investigate the inclusion of fire risk assessment in the OR's well-established universal protocol called surgical time-outs.[4] In 2015, the ECRI (formerly Emergency Care Research Institute) has estimated a range from 200 to 240 OR fires occurring annually in the United States.[5] The estimation of the actual number of OR fires is difficult to make because of lack of reporting. The rate of OR fires is comparable to other never events such as wrong-sided surgery and retained surgical instruments.[5] Case studies of OR fires show the consequences can be devastating for patients and caregivers because of disfiguring burns, and some cases result in death. Research studies on OR fires, including root cause analyses, revealed that the causes of OR fires are largely preventable.[6]

In high-income countries, burns occur disproportionately to racial and ethnic minorities such that socioeconomic status—more than cultural or educational factors—accounts for most of the increased burn susceptibility and death and disability from a burn in the OR. Risk factors for fatal burns include those related to socioeconomic status, race and ethnicity, age, and gender, as well as those factors pertaining to region of residence, intent of injury, and comorbidity.[5]

The OR fire triad consists of 3 components that must be present for a fire to occur: an ignition source, an oxidizer, and fuel.[5] In the OR, 3 separate people are usually responsible for each part of the fire triad. Typically, the surgeon is responsible for the ignition source, which is often an electrosurgical unit. The anesthesia provider is responsible for the oxidizer, in many cases oxygen. And the nursing staff is responsible for the fuel, which includes drapes and dressings. The addition of fire risk assessment during the surgical time-out opens lines of communication among members of OR staff to discuss how fire can be avoided. Regardless of the area of responsibility, the entire team in the OR is responsible for the safety of the patient.

For many years, the aviation military has used checklists to ensure proper functioning of equipment and preparation of personnel. In the early days of aviation, the act of flying a plane was not complicated. However, the mechanics of aviation became increasingly complicated, necessitating a checklist for pilots to ensure they had performed all necessary checks and cross-checked the necessary steps for a safe flight. In line with the aviation industry's successful use of checklists in preventing accidents, Haynes et al[7] published a seminal study on the implementation of a surgical safety checklist; the result of this collaboration with the World Health Organization in the development and testing, was a 19-item checklist to be used by any team performing a surgery. The checklist was found to be an effective intervention in reducing the rate of inpatient complications from 11% to 7% ($P \leq .001$) and reducing the death rate from 1.5% to 0.8% ($P = .003$) before and after implementation of the checklist, respectively. Haynes et al[7] emphasized that the implementation of the surgical checklist, just as with any change in practice, required a change in practice culture at each institution in which it was implemented. Given the data on other surgical safety checklists and the potentially dire consequences of fire, checklists can make a notable difference in fire rates. Other studies have also shown the use of a checklist to be an effective tool in improving safety in the OR.[8,9]

Currently, it is standard practice or universal protocol for all surgical team members to perform a time-out before any procedure or surgery. These time-outs occur at the bedside before a bedside procedure and in procedural areas such as hospital ORs and ambulatory surgical centers. Typical checks in the time-outs include, but are not limited to, patient name and birth date, team members and their role, correct procedure, correct surgical site, allergy information, and prophylactic antibiotics. These checks help prevent the occurrence of never events such as wrong-sided surgery and retained surgical instruments. Fire risk assessment can be added to the checklist for surgical time-outs to facilitate fire risk communication such as identification of potential sources of the fire triad and physical verification and verbalization of the nearest location of fire extinguishers among surgical team members. The knowledge and attitudes of anesthesia providers have not been previously studied as potential barriers to the adoption of fire risk assessment into the surgical time-out checklist.

To date, research studies examining the knowledge and attitudes on fire risk assessment during surgical time-outs among anesthesia providers have been lacking. This assessment of anesthesia providers' knowledge and attitudinal barriers to fire risk assessment during surgical time addressed the current knowledge gap on why fire risk assessment is still not integrated into the checklist for surgical time-outs. An anonymous online survey was conducted with the following objectives:

1. To assess the *perceived* knowledge and attitudes of Certified Registered Nurse Anesthetists (CRNAs) and student registered nurse anesthetists (SRNAs) on fire risk assessment during time-outs.

2. To explore the association of sociodemographic factors with *perceived* knowledge or attitudes on fire risk assessment among CRNAs and SRNAs.

Conceptual Framework

Solberg's[10] theory of practice change guided the development of this study. Solberg[10] posits that for new knowledge to result in practice change and improved patient care, the parties involved must buy into it. New knowledge must be accompanied by priority, change process capability, and care process content. *Priority* is defined as obtaining the basic knowledge, increasing change process capability, and enhancing the care process content. When all these 3 elements are combined, they create the potential for improvements in patient care.

One of the first steps to effecting change is the acquisition and sharing of new knowledge. Once the new knowledge is acquired, practice change can effectively begin. Knowledge acquisition can also help in providing a common understanding among all members involved in the improvement or practice change. When there is sufficient knowledge sharing, priority, capability to change, and care process content, improvements can then be made in the delivery of patient care. In this study, the data obtained from CRNAs and SRNAs pertaining to their current perceived knowledge and attitudes on fire risk assessment can serve as guides to the development of educational initiatives aimed at facilitating practice. The insights gained from this study were helpful in delineating the contents of educational initiatives, specifically meeting the adult learning needs[11] of CRNAs' and SRNAs' knowledge gaps on fire risk assessment during surgical time-outs.

Literature Review

• ***Culture of Safety in the Operating Room.*** The American Society of Anesthesiologists (ASA) states that the fire triad, which consists of an oxidizer, an ignition source, and a fuel, must be present for fire to occur in the OR.[12,13] Common oxidizers in the OR are oxygen and nitrous oxide[14,15]; fuel includes surgical drapes, gauze, dressings, and hair; and ignition sources include electrosurgical units such as cautery and lasers.[15,16] Recent reports of OR fires made patient safety advocates more resolute to push lawmakers for tougher government regulations that can significantly prevent fires in the OR.[17]

The culture of safety in the OR and current fire safety standards in the OR are central concepts to this study. Although CMS considers an OR fire an event that should never occur, there is currently no standard practice or universal protocol to address the various fire risks among members of the surgical care team. Operating room fire drills and OR fire safety plans[18,19] could save lives, but they are not performed on a daily basis, unlike the fire safety assessment checklist. Much remains to be done to reduce the risk of OR fires to zero.

The aviation industry has been using checklists for many years to reduce the risk of human error. Checklists are commonly used in hospitals when providers insert central venous lines, wean patients from mechanical ventilators, and discuss daily goals of patient care. In the critical care arena, use of checklists has been shown to reduce intensive care unit length of stay, infection rates, and ventilator-days.[20] The 2 most recent review articles on the use of checklists to prevent human errors in the OR highlighted the improvement of surgical patient outcomes, including reduced morbidity and mortality.[21,22] A similar checklist could reduce fire risk.[1]

• ***Reported Fire Accidents in the Operating Room.*** Mehta and colleagues[23] performed closed-claims analysis using the ASA Closed Claims Project database related to OR fires. Most OR fires occurred during monitored sedation, where the oxygen source, often a nasal cannula, is typically open to the environment.[23] Oxygen was the most common oxidizer, found to be in use in 95% of the cases reported in the Closed Claim Analysis database. Cautery was determined to be the most frequent ignition source of OR fires. Fires in the OR were also found to be more common during outpatient procedures.[23] The federal government does not mandate reporting surgical fires to insurance databases; thus, not all cases are accounted for in this analysis. Nonetheless, this closed claim analysis does provide valuable information related to factors that increase the risk of OR fires.

Operating room fires can happen even at the top-tier medical centers in the United States that have comprehensive fire prevention policies and procedures. Between 2009 and 2010, the Cleveland Clinic reported 6 OR fires resulting in 3 patient injuries.[24] These OR fires were reported by Cleveland Clinic administrators to CMS officials during scheduled inspection visits to the Cleveland Clinic. Based on the recommendations from CMS officials, alcohol-based preparations, believed to be the cause of the fires, were removed from the ORs. Alcohol-based preparations have been previously found as fire risks in the OR.[25]

• ***Operating Room Fire Safety Guidelines and Recommendations.*** The ASA published a practice advisory related to OR fires. The ASA was unable to publish a guideline or standards because of the lack of controlled studies related to fire in the OR.[26,27] The ASA delineates high-risk procedures as the following: one in which an ignition source comes close to an oxidizer.[14] The practice advisory delineates steps for dealing with fires in the OR. The ASA also recommends that the entire surgical team should discuss each case and whether a risk of fire exists. A common theme in the practice advisory is effective communication among all members of the entire surgical team.[14]

The Association of periOperative Registered Nurses (AORN) has also published a guidance statement regarding fire in the OR. The AORN[28] suggests performing OR fire drills to allow staff to practice the roles they would perform if an OR fire occurred. The AORN, in its guidance statement, emphasizes the importance of and need for education pertaining to fire safety in the OR for all members of the OR team.[28]

The US Food and Drug Administration[29] recommends fire safety practices for healthcare professionals in the OR. There is not, however, a standard of care for routine assessment of the existence of OR fire risk such as the use of a fire risk assessment checklist. There is a paucity of evidence in the literature regarding incorporation of fire risk assessment into the surgical time-out. Practice standards do not exist for OR fire risk assessment, although there are recommendations from industry and professional organizations.

Methods

• ***Study Design.*** This study used a descriptive, cross-sectional online survey designed to assess the perceived knowledge and attitudes of CRNAs and SRNAs regarding fire risk assessment during surgical time-outs.

• ***Sample.*** The participants in the study included CRNAs and SRNAs who are active members of the Illinois Association of Nurse Anesthetists (IANA), a member of the American Association of Nurse Anesthetists (AANA), the official and national professional organization of CRNAs and SRNAs in the United States. The AANA represents more than 50,000 CRNA and SRNA members nationwide.[30] In a typical online survey, a 30% response rate could be expected, or 485 completed surveys of 1,600 sent, based on the systematic review by Cook et al[31] on web- or Internet-based survey response rate. In this study, a power analysis estimated that a sample of 112 subjects (mean difference of 0.2; SD of 0.75) would have 80% power to detect statistically significant differences between dichotomous sociodemographic groups (eg, male or female) at the 0.05 α level (2-tailed test) using independent-samples *t*-test statistics.

• ***Setting.*** Members of IANA come from and work in various towns and cities in the entire state of Illinois (rural, suburban, and urban areas). Study participants completed the survey on any computer or mobile device of their choice. The sample is a good representative of the distribution of CRNAs around the state of Illinois.

• ***Instruments.*** The online survey (Qualtrics, Provo, Utah) containing 3 sections used a sociodemographic questionnaire, assessment of perceived knowledge, and assessment of attitudes related to fire risk assessment during time-outs. Sociodemographic information included gender, age, ethnicity, education, and years of work experience. The second part of the online questionnaire was essentially a needs assessment inquiring about the current clinical practice of incorporating fire risk assessment into surgical time-outs. Participants wrote their answers as free text.

Overall, the online survey had 22 questions that included 5 on demographic information, 5 attitudinal questions, and 12 questions relating to OR fire safety *perceived knowledge*. On average, it took less than 15 minutes for the study participants to complete the online survey. The perceived knowledge and attitudes questions used in this study were modified from the original questionnaire developed by Upton and Upton[32] and modified to fit the context of the current study. The original questionnaire was validated and found to have a high reliability α coefficient with a Cronbach α of 0.87 when tested among a population of 500 nurses from the United Kingdom.[32]

Minor modifications of the questionnaire's items were reviewed by 2 research faculty members with a doctor of philosophy and a faculty member with a doctor of nursing practice (DNP) degree and expertise in nurse anesthesia. Each item in the questionnaire was checked for clarity, simplicity, accuracy, and relevancy for this current study. The Cronbach α for the perceived knowledge and attitudes components of the online survey tool was 0.896, indicating good reliability of the modified instrument used for this current study.

• ***Recruitment and Data Collection Procedures.*** The target population of CRNAs and SRNAs was approached via recruitment email distributed by the IANA. An email was sent to members of the IANA containing an information sheet that included the purpose of the study, information about privacy, rights of study participants, ability to cease participation in the study without penalty, and information regarding how to reach the investigators. Consent to participate in the study was implied by completing the online study. Participation was anonymous and voluntary.

• ***Analytic Procedure.*** Statistical analysis software[33] was used to conduct data analyses. Descriptive statistics using means, standard deviation, frequencies, and percentages were used to analyze the data on perceived knowledge and attitudes of the study participants regarding OR fire risk assessment during surgical time-outs. The underlying hypothesis of this study states that there is no difference in the perceived knowledge level and attitudes means between dichotomous categories of sociodemographic variables. Analysis of variance (ANOVA) was used to examine the statistical difference in the perceived knowledge and attitudes mean scores of 3 or more groups. Point biserial correlation statistics (a special case of Pearson *r*) was used to explore possible associations between attitudes or perceived knowledge mean scores and dichotomous categorical variables such as gender (male and female) and 2 age groupings (20-49 years of age and 50 years and above). Correlations were explored whether gender and age had any associations with perceived knowledge and attitudes on fire risk assessment that may directly or indirectly influence or serve as barriers to fire risk assessment integration into the surgical time-out.

Variable	No. (%)
Gender	
Female	91 (65.0)
Male	48 (35.0)
Age, y	
60 and above	29 (20.7)
50-59	42 (30.0)
40-49	25 (27.9)
30-39	25 (17.8)
20-29	5 (3.6)
Race-ethnicity	
Mixed race	1 (0.7)
Asian/Pacific Islander	3 (2.2)
Black/African American	2 (1.4)
Hispanic/Latino	2 (1.5)
White	131 (94.2)
Years of experience	
> 20 years	63 (45.0)
11-20 years	33 (23.6)
6-10 years	23 (16.4)
0-5 years	21 (15.0)
Level of education	
Associate or baccalaureate	24 (17.1)
Master's degree	97 (69.3)
Doctorate: DNP, PhD	19 (13.6)

Table 1. Sociodemographic Characteristics of Study Participants (N = 140)

• ***Human Subject Protections.*** This study received institutional review board approval from DePaul University, Chicago, Illinois. The questionnaires did not contain any personal identifiable information. Data were collected online, and all printed records were kept in a locked cabinet located in a locked and secured room of the principal investigator (K.C.). Any electronic records were kept on a computer that was always password-protected. There were no direct benefits for the study participants for their participation on this research project.

Results

• ***Study Participants.*** A total of 140 participants' complet-

Questionnaire item	Mean	SD
My workload is too heavy, so I don't have time for fire risk assessment during time-outs.	4.36	0.743
I don't believe fire risk assessment is necessary during time-outs for nurse anesthesia practice.	4.30	0.996
I resent having continuing education on fire risk assessment in relation to time-outs.	4.18	0.898
Fire risk assessment during time-outs is a waste of my time.	**4.39**[b]	0.826
I stick to tried and trusted methods on fire risk assessment but not during time-outs.	**3.91**[c]	1.108

Table 2. Mean Scores on Fire Risk Assessment Attitudes Scale[a]
[a]1 = strongly agree; 5 = strongly disagree.
[b]Highest mean score.
[c]Lowest mean score.

Questionnaire item	Mean	SD
1. My research skills in obtaining information on fire risk assessment during time-outs is:	**3.55**[b]	0.911
2. My information technology (IT) skills related to fire risk assessment during time-outs is:	**3.42**[b]	0.883
3. I monitor and review the current standards on fire risk assessment during time-outs.	**3.49**[b]	1.281
4. I know how to meet my information needs on fire risk assessment during time-outs.	3.91	0.920
5. I am aware of major information types and sources related to fire risk assessment during time-outs.	3.76	0.974
6. I am able to identify gaps in my professional practice pertaining to fire risk assessment during time-outs.	3.80	0.824
7. I am knowledgeable on how to retrieve information on fire risk assessment during time-outs.	3.98	0.766
8. I am able to critically analyze the set standards for fire risk assessment during time-outs.	3.92	0.816
9. I am able to determine how valid (close to the truth) are the data related to fire risk assessment during time-outs.	3.88	0.742
10. I am able to determine how useful fire risk assessment during time-outs is to clinical practice:	**4.11**[c]	0.691
11. I share ideas and information on fire risk assessment during time-outs with my colleagues.	**3.48**[b]	1.245
12. I disseminate new ideas related to fire risk assessment during time-outs with my colleagues.	**2.99**[b]	1.299

Table 3. Mean Scores on Fire Risk Assessment Knowledge Scale[a]
[a]1 = strongly disagree; 5 = strongly agree.
[b]Lowest mean scores.
[c]Highest mean score.

ed surveys were used for analysis, with an overall online survey response rate of 10.3%. Despite the low survey response rate, the target sample size of 112 was reached with more than 80% power to detect statistical differences in dichotomous groupings of sociodemographic variables. The sociodemographic characteristics of the study participants are described in frequencies and cumulative frequencies in Table 1. Among study participants, most had graduate degrees, with 69.3% (n = 97) holding a master's degree and 13.6% (n = 19) having a doctoral degree.

• ***Perceived Knowledge and Attitudes on Fire Risk Assessment.*** Overall, the attitudes mean scores of the study participants were positive. Table 2 shows the mean scores of each item on the attitudes scale. The first 5 questions assessed the study participants' attitudes toward fire risk assessment during time-outs. For the attitudinal questions, a Likert-type scale was used for the responses to the questions as follows: (1) strongly agree, (2) agree, (3) neutral, (4) disagree, and (5) strongly disagree. The item with the highest positive attitudes mean score was the item "Fire risk assessment during time-outs is a waste of my time" (mean = 4.39; SD = 0.826). The attitudes item with the lowest mean score indicating a negative attitude was the item "I stick to tried and trusted methods on fire risk assessment but not during time-outs" (mean = 3.91; SD = 1.108).

The study participants were asked to answer questions assessing their perceived knowledge related to fire risk assessment during surgical time-outs as outlined in Table 3. For these perceived knowledge assessment items, the following Likert-type scale was used: (1) strongly disagree, (2) disagree, (3) neutral, (4) agree, and (5) strongly agree. For the perceived knowledge-based questions, a higher mean was associated with more perceived knowledge regarding fire risk assessment during surgical time-outs. The item with the highest mean score was the item "I am able to determine how useful fire risk assessment during time-outs is to clinical practice" (mean = 4.11; SD = 0.691). The item with the lowest mean score indicating perceived knowledge deficit on new ideas related to fire risk was the item "I disseminate new ideas related to fire risk assessment during time-outs with my colleagues" (mean = 2.99; SD = 1.299). Most (n = 139; 99%) of participants' perceived knowledge and ability to

Mean score	t	df	P value[a]
Attitudes by gender	−0.961	137	.338
Male (mean = 4.09)			
Female (mean = 4.23)			
Attitudes by age	−0.738	138	.462
20-49 years old (mean = 4.13)			
50 years and older (mean = 4.24)			
Knowledge by gender	1.093	137	.276
Male (mean = 3.77)			
Female (mean = 3.64)			
Knowledge by age	−0.711	138	.478
20-49 years old (mean = 3.65)			
50 years and older (mean = 3.74)			

Table 4. Gender and Age Differences in Knowledge and Attitudes Mean Scores (*t* Test)
[a]No statistically significant differences were found in mean scores for knowledge and attitudes by gender and age.

Variable	Correlation statistic	Mean score for attitudes	Gender
Mean score for attitudes	Point biserial correlation	1	.082
	P (2-tailed)		.338
		Gender	**Mean score for knowledge**
Mean score for knowledge	Point biserial correlation	−0.093	1
	P (2-tailed)		.276
		Years of clinical experience	**Mean score for knowledge**
Years of clinical experience	Point biserial correlation	1	.030
	P (2-tailed)		.727
		Mean score for attitudes	**Educational level**
Educational level	Point biserial correlation	0.122	1
	P (2-tailed)	.150	

Table 5. Correlation of Knowledge and Attitudes on Fire Risk Assessment With Sociodemographic Variables (N = 140)[a]
[a]No statistically significant correlation was found between sociodemographic variables such as gender, years of experience, and educational levels with mean scores in knowledge and attitudes on fire risk assessment.

retrieve perceived knowledge on fire risk assessment was not adequate, with 11 of 12 items in the perceived knowledge subscale having a mean score below 4. This score was considered only adequate if the responses were 4 = agree or higher at 5 = strongly agree. The valents of the anchors for perceived knowledge and attitudes questionnaires were intentionally reversed to reduce or eliminate acquiescence leading to a ceiling effect, which makes data interpretation later vague and less meaningful.

• ***Association of Sociodemographic Variables With Perceived Knowledge and Attitudes.*** The ages of the study participants were divided into 2 groups: those who were between the ages of 20 and 49 years and those who were 50 years of age and older. This grouping was done to conduct statistically powered comparison to detect meaningful differences in mean scores in perceived knowledge and attitudes. The mean scores of participants' attitudes toward fire risk assessment during time-outs were analyzed using independent-samples *t* test. There was no statistically significant difference in the attitudes regarding fire risk assessment during time-outs between the 2 age groups (t = −0.738; P = .462) and by gender (male and female participants, t = −0.961; P = .338). Regarding the mean scores on perceived knowledge related to fire risk assessment during time-outs, there was also no statistically significant difference in the study participants' perceived knowledge of fire risk assessment during time-outs by age groups (t = 1.093; P = .276). Details of all statistical *t*-test analyses for differences in mean scores in perceived knowledge and attitudes by dichotomous groupings of age and gender and their correlation statistics are reported in Tables 4 and 5, respectively.

An ANOVA was performed to compare the means of 3 or more groupings of study participants by educational level and years of clinical experience (Table 6). The ANOVA revealed that there was no statistically significant difference in perceived knowledge or attitudes mean scores on fire risk assessment during surgical

Comparison	*df*	*F*	*P* value[a]
Attitudes mean score by years of clinical experience			
Between groups	3	1.221	.304
Within groups	136		
Attitudes mean score by educational level			
Between groups	2	.369	.692
Within groups	137		
Knowledge mean score by years of clinical experience			
Between groups	3	.177	.912
Within groups	136		
Knowledge mean score by educational level			
Between groups	2	2.032	.135
Within groups	137		

Table 6. Analysis of Variance Comparing Mean Scores in Attitudes and Knowledge on Fire Risk Assessment Based on 3 of 4 Sociodemographic Groupings by Education Level and Years of Clinical Experience
[a]No statistical difference was found in the mean scores for attitudes and knowledge between and within 3 or more groups based on educational level or years of clinical experience.

time-outs among study participants with varying levels of experience or different levels of education. The study sample was homogeneous with respect to ethnicity, so no inferential test statistics were performed for this variable. A *t* test was performed for 2 groupings of gender and age range differences of the sociodemographic variables, but no statistically significant differences in the mean score for perceived knowledge and attitudes were observed.

Discussion

To our knowledge, this is the first study that assessed the perceived knowledge and attitudes of CRNAs and SRNAs regarding fire risk assessment during surgical time-outs. The attitudes across all study participants were positive, with a mean score of 4.23 of 5. This is consistent with other recent reports on perioperative nurses' positive attitudes toward the use of a checklist in the OR, which has been perceived by nurses as an effective tool in averting an error, improving surgical team communication, and reducing complications and morbidity.[34] A recent study from Brazil also reported that 470 members of the surgical teams, including most nurse technicians, have positive attitudes toward acceptance of checklist use in the OR. However, surgeons have been found to have negative attitudes toward checklist use and acceptance in the OR.[35] The anchors for the Likert-type questionnaires were intentionally varied from perceived knowledge items to attitudes items to prevent a ceiling effect.

The mean scores of perceived knowledge on OR fire assessment across all sociodemographic groups were not statistically significant between or within various groupings based on age, gender, years of clinical experience, and levels of education. It remains unclear what role perceived knowledge deficits or negative attitudes on OR fire risk assessment play in the lack of adoption of standard procedure on fire risk assessment, which is just a quick and easy use of a fire risk checklist in the OR during surgical time-outs. Assessment of perceived knowledge, attitudes, skills, motives, and barriers are fundamental steps toward changing the culture of practice on OR patient safety.

The perceived informational deficits on fire risk assessment could hinder the formal development of an OR fire risk checklist that is "shovel ready" for integration into the surgical time-outs as part of the universal protocol at anesthesia providers' local place of employment. This study also revealed that CRNAs and SRNAs perceived a lack of knowledge about new ideas for disseminating fire risk assessment during time-outs. These informational needs reported by CRNAs and SRNAs can be addressed by new educational initiatives or continuing nursing education credits directed toward preventing OR fires and improving patient safety. Hospital administrators and nursing leaders must continue to assess knowledge deficits (actual and perceived) pertaining to OR patient safety and safe working environment for all surgical team members. Time is a scarce resource among surgical team members. Innovative approaches such as online, web-based on-demand availability of education and training modules on OR fire risk assessment for surgical team members should be developed.

For successful implementation of change in clinical practice, there must be buy-in from key players as posited by Solberg.[10] A recent review of the literature on checklist use and successful checklist implementation emphasized the importance of enlisting institutional leaders as local champions, incorporating staff feedback for checklist adaptation, and reduction of any redundancy in the overall checklist procedures,[36] particularly in resource-limited settings in developing countries.[37] A similar review article also reported that adequate education and training are needed for successful checklist implementation, which is a key driver to checklist effectiveness in improving surgical patient outcomes.[38]

The findings from this study underscore information needs of the CRNAs and SRNAs and uncover the lack of a standard procedure in the use of fire risk assessment checklist during surgical time-outs. A simple, but comprehensive, validated, and reliable OR fire risk assessment checklist could potentially identify the fire risk factors, improve communication of fire risks among surgical team members, and prevent the occurrence of never events such as patient burn or death due to OR fires.[8,9] Because CRNAs are well-trained and highly educated members of the surgical team, they are capable of taking a leadership role to effect change in practice, particularly in the area of OR patient safety.[30] The low response rate to our survey is worrisome, not because it casts doubt on the study itself, but because it indicates lack of CRNA/SRNA interest in this vital area, which needs urgent intervention.

• ***Limitations.*** This study has a number of limitations. The study participants included only CRNAs and SRNAs in the state of Illinois, so the results may not be generalizable across other geographic locations. The survey also assessed only the perceived knowledge and attitudes of CRNAs and SRNAs and did not include other surgical team members such as anesthesiologists, anesthesiology assistants, and perioperative nurses. The actual knowledge level of participants on fire risk assessment was not assessed given the amount of time required to develop a valid and reliable multiple-choice questions tool, which is suited more for a PhD dissertation than a DNP project. Because of differences in the educational preparation among surgical team members, there may be differences in the perceived knowledge and attitudes based on roles in the surgical team. Several studies have reported negative attitudes of surgeons toward checklist use and acceptance affecting overall teamwork.[35,39,40] The sample in this study is composed primarily of whites, which is highly reflective of the current racial distribution in the national AANA membership.[30] This precludes the investigators from examining ethnicity as a potential factor for perceived knowledge deficit or poor attitudes on fire risk assessment. However, this study provides preliminary evidence that gender, level of education, years of education, and age are at least not associated with poor perceived knowledge or negative attitudes toward fire risk assessment during surgical time-outs among CRNAs and SRNAs.

• ***Future Direction for Research.*** Electronic health records are becoming ubiquitous in daily clinical practice, making the integration of an electronic fire risk assessment checklist easier to use and thereby improving acceptability ratings. Future studies aimed at examining potential barriers to fire risk assessment during time-outs are warranted before full implementation. The use of a checklist as a fire risk assessment tool in the OR should be explored because there are many review articles supporting the effectiveness of checklists in preventing human errors in the OR, including fires.[7,9,22,34,41-46]

• ***Implications for Practice.*** The survey results also indicate that CRNAs and SRNAs have self-reported informational needs on many aspects of fire risk assessment during surgical time-outs. Education should be the first step toward the integration of fire risk assessment into the surgical time-outs. The areas of educational need such as information technology and research skills in retrieving information relevant to OR fire risk assessment and ways to share new ideas on OR fire risk should be addressed by future educational initiatives on OR fire safety. Additional training should be provided to all surgical team members to enhance their perceived knowledge of fire risks in the OR and to reinforce the need to eliminate one element of the fire triad using a checklist that facilitates structured meaningful and relevant communication among surgical team members.[40,47,48]

Perceived barriers to knowledge must be removed to facilitate practice culture change from all members of the surgical team.[40] There is still no current standard procedure that requires implementation of the assessment of fire risk in the OR. Moving forward, a standard of practice using an evidence-based OR fire assessment checklist should be developed and tested in ORs and ambulatory surgical centers for its applicability, usability, acceptability, and effectiveness in reducing human error that could lead to a patient's burn injuries or death due to a highly preventable OR fire. A recent publication examining barriers and facilitators to checklist implementation revealed many barriers, including poor planning, lack of accountability, design issues, implementation issues, problematic integration into existing processes, and resistance from senior clinicians such as surgeons and anesthesiologists.[41] A systematic way of integrating a fire assessment checklist into existing processes should be planned carefully, and all surgical team members must be involved in the planning stages to avoid the pitfalls described by Mayer et al[48] and Russ et al.[40,48] Obtaining the patient's feedback on the use of a checklist can also be very beneficial in ultimately improving overall surgical outcomes.[49]

Conclusion

Consistent with other study findings involving perioperative nurses, CRNAS and SRNAs have positive and favorable attitudes toward fire risk assessment and the use of checklists in the OR. However, their self-perceived knowledge deficits on fire risk assessment could hinder the development, adoption, and integration of fire risk assessment into the existing universal protocol for surgical time-outs. Perceived knowledge deficits on fire risk assessment must be addressed before implementation of an OR fire risk assessment checklist. Actual measurement of fire risk assessment knowledge using valid and reliable tools should be an area for further research. Ways to improve sharing and dissemination of new information related to OR fire risks are warranted among CRNAs and SRNAs as well as other members of the surgical team.

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