

## Original Article

## Knowledge of the Operating Room Team Members about Surgical Smoke Safety

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### Abstract

**Background:** Providing a safe environment in perioperative care is important for both operating room team members and patients. This study aims to identify knowledge of the operating room team members about surgical smoke safety.

**Methods:** The cross-sectional in nature study was conducted with the volunteer participation of 62 personnel who were composed of surgeons, anesthetists, surgical technicians, anesthesia technicians, and surgical nurses.

**Results:** Average age of the participants was  $29.11 \pm 5.94$ . Of all the participants, 66.1% were surgical nurses and 74.2% worked in night + day shifts. In addition, it was found that 83.9% of the participants did not participate in any training programs on surgical smoke safety. Correct answer total mean score of the operating room personnel was  $5.19 \pm 1.46$  (min: 2, max: 10).

**Conclusions:** Institutional policies, supervisions, and well-designed education programs are needed in order to bring the knowledge of the operating room personnel to a sufficient level and increase their awareness about occupational health and occupational exposure.

**Keywords:** occupational health, occupational exposure, surgical smoke, knowledge

### Introduction

Surgical smoke is produced when the tissue is cut and coagulated with lasers or electro-surgical devices. Studies report that surgical smoke is a severe workplace danger for more than 500.000 health workers (Ball, 2010; Barrett & Garber, 2004; Ulmer, 2008). Surgical smoke is a risk for the patient, personnel and environment. When lasers or electro cautery are used, mutagen gases, carcinogens, particulates involving DNA components, or Human Papilloma Virus (HPV) are spread in the air with smoke. Therefore, unless necessary precautions are taken, many operating room personnel have to inhale this air. In this regard, surgical smoke could increase the risk of acute and chronic lung diseases; cause acute headache; lead to eye, nose, throat irritation and pain; and cause dermatitis and colic. When the bacterial or viral fragments in the smoke are inhaled, transmission of contagious diseases may occur. Surgical smoke is also a source of concern for the presence of carcinogen and its mutagenic effects (Ball, 2010; Okoshi et al., 2015). The operating room team should evaluate the

potential dangers of the surgical smoke and encourage the use of smoke evacuation devices in order to decrease the potential health dangers to minimum. Normal surgical masks and ventilating systems are not sufficient for controlling this problem (Ilce, Yuzden & Yavuz van Giersbergen, 2017; Romano, Gustén, De Antonellis & Joppolo, 2017). Especially the studies conducted in recent years have shown that surgical smoke resulting from the use of energy-producing devices during surgery involves poisonous and biologically dangerous matters for perioperative team members and patients. Especially surgical nurses could be exposed to too much surgical smoke that routinely causes a set of symptoms and adverse effects (Asdornwised et al., 2018; Ilce, Yuzden & Yavuz van Giersbergen, 2017; Romano, Gustén, De Antonellis & Joppolo, 2017). On the other hand, despite the current increase in the knowledge about this issue, perioperative personnel might not comply with the issue of evacuating the smoke during the surgical procedures. Therefore, supervisions and trainings

on surgical smoke are recommended (Fencl, 2017; York & Autry, 2018).

Generally, perspective on surgical smoke knowledge is not at a desired level in our country. Quality standards of the Department of Quality and Accreditation in Health mentions standards about the general ventilation system of the operating room, but it does not include surgical smoke (Usta, Aygin, Bozdemir & Ucar, 2019). Studies on the risks of surgical smoke, precautions taken for protection, and evidence-based practices are very limited in number in the Turkish literature. Therefore, this study aims to identify knowledge of health personnel that have roles in perioperative care about surgical smoke safety.

## Methods

**Participants and Setting:** This study, which aims to identify knowledge of health personnel that have roles in perioperative care about surgical smoke safety, adopted a descriptive and relational screening design. The study was conducted between December 2018 and February 2019. The target population was 88 personnel that included surgeons, anesthetists, surgical technicians, anesthesia technicians, and surgical nurses working in a state hospital in the eastern part of Turkey. The sample included 62 health professionals who were 18 and over, who had no communication problems, who worked in the surgery units as surgeons, anesthetists, surgical technicians, anesthesia technicians, or surgical nurses, and who accepted to participate in the study. Those who had health report or were on annual leave during the time the study was conducted were not involved in the study.

**Data Collection and Data Analysis:** Data were collected by the researcher through the “Personal Information Form” and the “Surgical Smoke Safety Questionnaire” (SSSQ). The participants who worked in the identified state hospital and who accepted to participate in the study were informed about the purpose of the study and how to fill in the questionnaire. They were asked to fill in the questionnaire individually; the forms were then collected back by the researcher. Completing the questionnaires took approximately 5 to 10 minutes. The parts that were not completed were considered as lost data. The Personal Information Form was composed of 10 items that included personal information, years of experience, and statements about having received trainings on surgical smoke safety.

Surgical Smoke Safety Questionnaire was composed of 10 items prepared in line with the literature (Fencl, 2017). The form was just translated from English to Turkish. Data were analyzed using SPSS package programming. Analyses included numbers, percentages, means, Kolmogorov Smirnov test, Kruskal Wallis, Mann Whitney U, and Spearman correlation tests.

**Ethical Considerations:** Written approval was obtained from the institution where the study was conducted. Ethical approval was approved by the Independent Ethics Committee of the University and agreed with the ethical principles of the Declaration of Helsinki. Moreover, the participants’ consent was obtained after they were informed about the purpose of the study and the data collection forms used in the study.

## Results

**Demographics:** Average age of the participants was  $29.11 \pm 5.94$ ; average working experience was  $5.16 \pm 4.09$  years on the average; and weekly working was  $53.39 \pm 14.45$  hours on the average. Of all the participants, 61.3% were males, 53.2% were married, 72.6% had undergraduate degree, 66.1% were surgical nurses, and 74.2% worked in night + day shifts. In addition, 75.8% of the participants received in-service trainings regularly. However, 83.9% of the participants did not participate in any training programs about surgical smoke safety (Table 1).

**Surgical Smoke Safety Questionnaires and Answers:** Majority of the participants were found to answer the 1<sup>st</sup>, 2<sup>nd</sup>, 6<sup>th</sup>, 8<sup>th</sup>, 9<sup>th</sup>, and 10<sup>th</sup> questions correctly (Table 2).

**Distribution of the Surgical Smoke Safety Questionnaire (SSSQ) correct answer total mean score according to the socio-demographic and professional features of the health personnel:** SSSQ correct answer total mean score of the operating room personnel who participated in the study was found  $5.19 \pm 1.46$  (min: 2, max: 10). Especially, Surgical nurses’ SSSQ correct answer total mean score was found  $5.10 \pm 1.56$ . Comparison of the Surgical Smoke Safety Questionnaire (SSSQ) correct answer total mean score of the personnel according to marital status, profession, general working hours, participating in the in-service trainings regularly, and having received trainings on surgical smoke indicated no statistically significant differences between the total mean scores ( $p > 0.05$ ; Table 3). Comparison of the Surgical Smoke Safety Questionnaire (SSSQ) correct answer total mean

score of the personnel according to gender and education level indicated no statistically significant differences between the total mean scores ( $p < 0.05$ ; Table 3). An analysis of the relationship between SSSQ correct answer total mean score and age, weekly working hours, and years of experience indicated significant

relationships ( $p > 0.05$ ; Table 4). However, despite the positive and highly significant relationship between age and experience ( $p < 0.01$ ; Table 4), there was a positive relationship between years of experience and weekly working hours ( $p < 0.05$ ; Table 4).

**Table 1. Sample Characteristics (N=62)**

Variable	N	(%)
<b>Gender</b>		
Male	38	61.3
Female	24	38.7
<b>Marital Status</b>		
Married	33	53.2
Single	29	46.8
<b>Education Level</b>		
Health High school	11	17.7
Undergraduate degree	45	72.6
Master's and Doctorate degree	6	9.7
<b>Profession</b>		
Surgeon	3	4.8
Anesthetist	3	4.8
Surgical Technician	2	3.2
Anesthesia Technician	13	21
Surgical Nurse (sterile and circular)	41	66.1
<b>General Working Hours</b>		
Day	16	25.8
Night/Shift + Day	46	74.2
<b>Regular In-service Training Programs</b>		
Yes	47	75.8
No	15	24.2
<b>Having participated in a Training Program about Surgical Smoke Safety</b>		
Yes	10	16.1
No	52	83.9
<b>Average Working hours (weekly)</b>	53.39±14.45 (min: 18, max: 80)	
<b>Experience in profession (year)</b>	5.16±4.09 (min: 1, max: 20)	
<b>Age</b>	29.11±5.94 (min: 20, max: 44)	

**Table 2. Questions in the Surgical Smoke Safety Questionnaire**

Questions	Options	Number (%)
1. Harmful elements and substances known to be contained in surgical smoke include 1. bacteria. 2. carcinogenic particles. 3. hydrogen cyanide. 4. viruses.	a. 1 and 2 b. 3 and 4 c. 1, 3, and 4 d. 1, 2, 3, and 4*	6 (9.7) 2 (3.2) 7 (11.3) 47 (75.8)
2. The Occupational Safety and Health Administration estimates that more than 500,000 health care providers are exposed to harmful surgical smoke every year.	a. true* b. false	59 (95.2) 3 (4.8)
3. Potential dangers of surgical smoke for the patient include 1. anesthesia complications. 2. carbon monoxide exposure. 3. delays caused by decreased visibility of the surgical field. 4. port site metastasis.	a. 1 and 4 b. 2 and 3 c. 2, 3, and 4* d. 1, 2, 3, and 4	3 (4.8) 6 (9.7) 15 (24.2) 38 (61.3)
4. Surgical smoke generated during laser procedures is _____ smoke generated during electrosurgical procedures.	a. more hazardous than b. less hazardous than* c. equally as hazardous as	20 (32.3) 20 (32.3) 22 (35.5)
5. Policies and procedures for evacuating surgical smoke are considered	a. an administrative control. * b. an engineering control. c. an internal control. d. a work practice control.	4 (6.5) 7 (11.3) 14 (22.6) 37 (59.7)
6. A surgical mask provides sufficient respiratory protection during high-risk, aerosol-generating procedures.	a. true b. false*	28 (45.2) 34 (54.8)
7. The first line of defense against surgical smoke exposure is	a. a fit-tested N95 respirator. * b. a smoke evacuation system in addition to room ventilation. c. a surgical mask. d. adherence to policies and procedures.	7 (11.3) 18 (29) 13 (21) 24 (38.7)
8. The smoke capture device (e.g., wand, tubing) should be placed as close as possible to the surgical site.	a. true* b. false	48 (77.4) 14 (22.6)
9. The decision to use a smoke evacuator should be made based on	a. the surgeon's preference. b. the patient's request. c. a group decision by the surgical team. d. whether the procedure will generate surgical smoke.*	5 (8.1) 2 (3.2) 15 (24.2) 40 (64.5)
10. Policies and procedures for surgical smoke safety should address 1. evacuating all surgical smoke. 2. handling used supplies using standard precautions. 3. positioning the smoke capture device. 4. selecting a smoke evacuation system and supplies.	a. 1 and 2 b. 3 and 4 c. 2, 3, and 4 d. 1, 2, 3, and 4*	3 (4.8) 3 (4.8) 8 (12.9) 48 (77.4)

\*Correct answer

**Table 3. Distribution of the Surgical Smoke Safety Questionnaire (SSSQ) correct answer total mean score according to the socio-demographic and professional features of the personnel (n=62)**

Variables	n (%)	SSSQ	SSSQ
		X±SD	U/KW
<b>Gender</b>			
Male	38 (61.3)	5.50 ± 1.24	U=293 p=0.016*
Female	24 (38.7)	4.71 ± 1.68	
<b>Marital Status</b>			
Married	33 (53.2)	5.27±1.58	U=452 p=0.70
Single	29 (46.8)	5.10±1.34	
<b>Education Level</b>			
Health High school	11 (17.7)	4.64±1.20	KW=8.487 p=0.014*
Undergraduate degree	45 (72.6)	5.09±1.34	
Master's and Doctorate degree	6 (9.7)	7.00±1.67	
<b>Profession</b>			
Surgeon	3 (4.8)	6.33±1.15	KW=4.094 p=0.393
Anesthetist	3 (4.8)	6.00±1.00	
Surgical Technician	2 (3.2)	5.00±1.41	
Anesthesia Technician	13 (21)	5.08±1.32	
Surgical Nurse (Sterile and circular)	41 (66.1)	5.10±1.56	
<b>General Working Hours</b>			
Day	16 (25.8)	4.63±1.20	U=251 p= 0.067
Night/ Shift +Day	46 (74.2)	5.40±1.52	
<b>Regular in-service Training Programs</b>			
Yes	47 (75.8)	5.04±1.51	U=257.5 p= 0.109
No	15 (24.2)	5.67±1.23	
<b>Having participated in training programs about surgical smoke safety</b>			
Yes	10 (16.1)	4.90±0.73	U=225.5 p= 0.498
No	52 (83.9)	5.25±1.57	

\*p&lt;0.05 \*\*p&lt;0.01

**Table 4. The relationship between SSSQ correct answer total mean score and age, weekly working hours and years of experience**

		SSSQ correct answer total score	Age	Weekly working hours	Years of Experience
<b>Age</b>	r	.123	1	.155	.740
	p	0.340		0.229	0.000**
<b>Weekly working hours</b>	r	.115	.155	1	.297
	p	0.372	0.229		0.019*
<b>Years of Experience</b>	r	.086	.740	.297	1
	p	0.505	0.000**	0.019*	

\*p&lt;0.05 \*\*p&lt;0.01

## Discussion

Evidence on the hazardous effects of surgical smoke has long been reported in literature and known by professional institutions, yet surgical smoke remains to be a safety threat for patients and perioperative personnel (Asdornwised et al., 2018; Edwards & Reiman, 2012; Ulmer, 2008). A study conducted showed that a team that was composed of surgical nurses and educators tried to increase compliance with the policies and procedures for the management of the surgical smoke. As a result of a ninety-day application, quantitative data demonstrated 14.6% increase in the use of surgical smoke evacuation. This education intervention increased awareness of the personnel in decreasing the presence of surgical smoke, and helped to provide a safer environment for the patients, personnel, and the operating room team (Chavis, Wagner, Becker, Bowerman, & Jamias, 2016). Results of the present study showed that the majority of the participants did not participate in any trainings on surgical smoke safety, which might have resulted from lack of education policies or lack of compliance of the workers.

Studies recommend the use of smoke evacuation system as the primary control precaution for the protection of surgical personnel and patients. In addition, motivation and knowledge of the operating room personnel, who have important roles in preoperative care, as well as their smoke evacuation practices with appropriate equipment are of great importance (Ball, 2010; Edwards & Reiman, 2012; Gorman et al., 2014). A surgical N95 particulate filter mask should be used in case of a potential exposure to contaminants and contagious matters. This face mask prevents miscellaneous particulates from entering into human body to a large extent; it is designed for protecting the user from both droplets and particulates in the air (Pierce, Lacey, Lippert, Lopez, & Franke, 2011; Pollock, 2007). All health professionals should be careful because it is known that pathogens in blood are released during the procedures in the patients infected with HPV, HIV and hepatitis (Fowler et al., 2004). Any health professional to use these types of respiration devices should be trained on when and how to use the respiratory equipment (Benson, Novak, & Ogg, 2013). The present study found that the Surgical Smoke Safety Questionnaire (SSSQ) correct answers rate was at a medium level. In addition, a significant difference was found between the

Surgical Smoke Safety Questionnaire (SSSQ) correct answer total mean score according to gender and education level (Table 3). In this regard, especially males and master or doctorate students had higher correct answer ratios. It is important to become aware of the exposure to surgical smoke because it could be dangerous for many people in the operating room including the patient (Fencl, 2017; Schultz, 2014; Shah, 2012). Despite the evidence about the hazardous effects of the surgical smoke that has been known for years, members of the perioperative team generally are not knowledgeable about these effects or appropriate smoke evacuation rules (AORN, 2017; Ball, 2010; Ball, 2012; Steege, Boiano, & Sweeney, 2016). In addition, in the electro surgery procedures, although the smoke produced by electro surgery is more dangerous than the smoke produced by lasers, researchers found that there was a higher amount of compliance with the surgical smoke evacuation during laser procedures (Edwards & Reiman, 2012; Steege, Boiano, & Sweeney, 2014). Despite the fact that the studies conducted in Turkey reported the problems experienced by the nurses and doctors as a result of being exposed to surgical smoke, the operating room team was found to have little information about the hazardous effects of the smoke; and they did not take any precautions about it. In addition, majority of them were found to use only masks to get protected from the smoke (Ilce, Yuzden, Yavuz van Giersbergen, 2017). The present study found no significant relationships between SSSQ correct answer total mean score and age, weekly working hours and years of experience in profession. However, a positive, highly significant relationship was detected between age and years of experience in profession (Table 4). There was also a positive, significant relationship between years of experience and weekly working hours (Table 4). The relationship between years of experience, age and weekly working hours was somewhat expected. Studies show that smoke in operating rooms affects healthcare professionals. Unfortunately, the health care professionals do not seem to take any precautions that would protect them from the hazardous effects of the smoke (Fencl, 2017; Ilce, Yuzden, Yavuz van Giersbergen, 2017; Okoshi et al., 2015). This finding is considered to result from the insufficient institutional policies and lack of supervisions and trainings on this issue.

The limitation of this study is that it was conducted in one hospital and with a small group of participants. Such study should be carried out in hospitals with various systems and in larger groups. This way, it would be possible to raise awareness of the institutions and workers about surgical smoke, which is a neglected issue.

### Conclusion

In conclusion, providing a safe environment in perioperative care is important for both operating room team members and patients. Therefore, it is recommended to raise awareness about the dangers of surgical smoke and take the necessary precautions in order to decrease the risk of exposure. In addition, institutions should provide the equipment required for smoke evacuation; and safety of patients and workers should be enhanced through institutional policies and continuous supervisions and trainings. All operating team members should ensure the safety of all surgical patients by protecting them from the hazards of surgical smoke. Hospitals should provide education for perioperative team members on the risks of surgical smoke and teach implementation methods for smoke evacuation. Moreover, hospital authorities should increase smoke evacuation compliance on all surgical smoke generating procedures.

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