ISSN: 2378-3397

Çavdar et al. Int J Surg Res Pract 2022, 9:140
DOI: 10.23937/2378-3397/1410140
Volume 9 | Issue 2
Open Access

International Journal of
Surgery Research and Practice

RESEARCH ARTICLE

Protection Status of Healthcare Professionals Working in the Operating Room from Surgical Smoke

İkbal Çavdar, PhD, MSc, RN[1], Yasemin Özhanlı, PhD, MSc, RN[2], Ahmet Karaman, PhD, MSc, RN[3], Ayfer Özbaş, PhD, MSc, RN[1], Çağla Daştan, MSc, RN[4] and Ertuğrul Göksoy, MD[5]*

[1]*Surgical Nursing Department, Florence Nightingale Faculty of Nursing, Istanbul University Cerrahpaşa, Turkey*

[2]*Division of Nursing, Surgical Nursing Department, Kocaeli University, Turkey*

[3]*Surgical Nursing Department, Mersin University, Turkey*

[4]*Cerrahpaşa Faculty of Medicine Hospital, İstanbul University-Cerrahpaşa, Turkey*

[5]*Department of General Surgery, İstanbul University-Cerrahpaşa, Turkey*

***Corresponding author:** *Yasemin Özhanli, PhD, MSc, RN, Faculty of Health Sciences, Division of Nursing, Surgical Nursing Department, Kocaeli University, Umuttepe Campus, 41000, İzmit, Kocaeli, Turkey, Tel: +9026230310-00/4733*

Abstract

Background: Despite knowledge of the dangerous components of surgical smoke and evidence-based practices to control surgical smoke, healthcare professionals continue to be exposed to surgical smoke. It is critical to determine the possible damages of surgical smoke during the operation and to minimize these damages.

Aim: The study was aimed to determine the surgical smoke protection status of health professionals working in the operating room.

Material and methods: The population of the study comprised of health professionals (N = 206) working in the operating rooms of three hospitals in Istanbul. The sample who had a minimum of 6 months of work in the operating room between August 2016 and April 2017 and were willing to participate in the study. The number of samples constituted 67.8% (n = 139) of the population. Before starting the study, written approvals were obtained from the ethical board and institutions where the study was performed. The data were collected using the "Data Collection Form" developed by the researchers. Descriptive tests such as frequency, mean, and standard deviation were used in the analysis of the data, and Chi-square analysis was performed for comparison tables.

Results: It was determined that 82.7% of the sample group did not receive training on surgical smoke, the most commonly used method of protection was surgical mask (61.6%), and the first three symptoms they frequently experienced after surgery were fatigue (72.8%), headache (64.7%) and eye burning (43.4%), respectively.

Conclusions: Research findings showed that healthcare professionals working in the operating room experienced surgical smoke-related problems, but did not use effective methods to avoid the effects of surgical smoke.

Keywords

Operating room, Surgical smoke, Smoke inhalation, Protection from surgical smoke, Healthcare professionals

Introduction

Developing technology has brought many innovations in the field of health as well as in other fields, but simultaneously it has also caused the emergence of factors that negatively affect the lives of health professionals. These factors create risks at different levels according to the units in which healthcare professionals work. Operating rooms, which are dynamic areas where advanced technology is utilized and where safe, qualified, and efficient health services are provided for patients and employees, are units with high-risk levels where there are many factors such as anesthetic substances, surgical smoke, radiation, laser, waste gases and heavy metals that negatively affect health [1,2]. One of these factors, surgical smoke, contains waste products and viruses in cells that appear with benzene, hydrogen cyanide, formaldehyde, bioaerosol, blood products as a result of the use of

Citation: Çavdar I, Özhanlı Y, Karaman A, Özbaş A, Daştan C, et al. (2022) Protection Status of Healthcare Professionals Working in the Operating Room from Surgical Smoke. Int J Surg Res Pract 9:140. doi.org/10.23937/2378-3397/1410140

Accepted: May 29, 2022; **Published:** May 31, 2022

laser or electrosurgery unit [3]. The National Institute for Occupational Safety and Health (NIOSH) and the Centers for Disease Control and Prevention (CDC) have reported that surgical smoke is harmful [4]. Despite the NIOSH evidence-based practices and recommendations on surgical smoke protection, exposure to surgical smoke continues, and the Occupational Safety and Health Administration (OSHA) reports that half a million healthcare workers are exposed to surgical smoke each year [5].

Studies demonstrate that the mutagenic effect of surgical smoke caused by the thermal destruction of 1 gram of tissue is similar to that of 6 unfiltered cigarettes and that more than 500,000 healthcare workers are exposed to surgical smoke each year [6,7]. Water vapour is formed due to thermal destruction as a result of cutting or coagulating tissues during electrocautery and laser use. It is known that inhalation of pathogens in the steam causes respiratory system diseases (acute pulmonary insufficiency, asthma, chronic bronchitis etc.), cardiovascular dysfunction, cancer development, viral infections (HIV, HPV, Hepatitis etc.), and various problems such as headache, cough, burning in the eyes, and nausea-vomiting [8-10].

In the literature, it has been revealed that the incidence of certain respiratory problems such as bronchitis, asthma, sinus infections, and allergies is twice as high in operating room nurses as in the general population [2,6]. In a study carried out in Japan, it is reported that many surgeons and operating room nurses are not aware of the potential harms of surgical smoke [2]. In a study conducted in the USA, it was determined that the incidence of asthma in operating room nurses was higher than that in executive nurses [11].

Despite knowledge of the dangerous components of surgical smoke and evidence-based practices to control surgical smoke, healthcare professionals continue to be exposed to surgical smoke [3]. Surgical smoke is a major problem that needs to be addressed and resolved by health professionals due to its negative effects on the respiratory and cardiovascular system, irritating the ocular and mucosal areas, and mutagenic effects [12,13]. It is critical to determine the possible damages of surgical smoke during the operation and to minimize these damages [14]. In this context, the study was carried out as descriptive to determine the surgical smoke protection status of health professionals working in the operating room.

Methods

Study design

The study was carried out as descriptive design type.

Study population and sample

The population of the study comprised of health professionals (N = 206) working in the operating rooms of three hospitals in Istanbul. The sample included 139 healthcare professionals who had a minimum of 6 months of work in the operating room between August 2016 and April 2017 and were willing to participate in the study. The number of samples constituted an average of two-thirds (67.8%) of the population. After piloting with 20 health workers at the first step of the study, the necessary corrections were made in data collection form and the pilot study results were not included in the study.

Data collection tools and collection of the data

The data were collected using the "Data Collection Form" developed by the researcher in line with the relevant literature [2,6,15,16]. This form consists of 2 sections (information on introductory features, information on surgical smoke protection) and a total of 26 questions evaluating different data.

In the first part, questions were raised to determine the demographic characteristics of health professionals working in the operating room such as age, gender, education level, occupation, year of working in the operating room, and the presence of chronic diseases.

In the second part, questions were related to the effects of surgical smoke and prevention initiatives such as the distance of the health professionals working in the operating room to the operating table during work, the protocols applied regarding where they work, the level of knowledge about surgical smoke and the symptoms they experienced [2,6,16]. The data were collected through the face-to-face interview method.

Data analysis

The study data were analyzed statistically by the IBM SPSS 22.0 (IBM Statistical Package for Social Sciences Corp.; Armonk NY, USA, 2013) software package. Besides the descriptive statistical methods (mean, standard deviation, and frequencies), the Chi-square test were used for comparison tables. The level of significance was assessed at a p-value of < 0.05.

Ethical aspect of research

The approval of the Clinical Studies Ethics Committee (decision number 259452 dated 18/07/2016); the written permission from the hospital, where the study data were collected, and the written and verbal consent of the individuals included in the study sample were obtained before commencing the study.

Results

The mean age of the individuals participating in the study was 34.44 ± 6.77 years. It was found that 77% of the sample group was female, 51.8% had a university degree, 78.4% were a nurse, 46% had worked for 9 years or more in the operating room, and 79.9% had a weekly working hour of 40-80 hours. It was determined that 80.6% of the sample group did not have a chronic

disease, and 36.7% developed a chronic disease after they started working in the operating room (Table 1).

The distribution of surgical smoke protection methods according to occupational groups is given in Table 2. Surgical mask (61.6%), aspirator (39.9%), and operating room general ventilation system (30.4%) were determined as the three most frequently used methods of protection among the participants, respectively (Table 2).

It was detected that 82.7% of the individuals participating in the study did not receive training on surgical smoke, and 87.8% stated that the institution did not have a waste gas protocol. There was no statistically significant difference between the education about surgical smoke and hospital waste gas protocol and the use of methods for prevention ($p > 0.05$) (Table 3).

It was determined that the most common postoperative problems of the participants were fatigue (72.8%), headache (64.7%), and burning eye (43.4%). Compared to the symptoms experienced by health professionals with their distance to the table during surgery, it was found that cough symptoms were more common in those with a distance of less than 50 cm than those with a distance of less than 50 cm and that the difference between them was statistically significant ($p < 0.05$), and that there was no difference in the incidence of other symptoms compared to the distance to the table ($p > 0.05$) (Table 4).

Table 1: Demographic characteristics of Participants (N = 139).

Demographic characteristics		Min*-Max**	Mean ± SD***
Age		22-60	34.44 ± 6.77
		n	%
Gender	Female	107	77
	Male	32	23
Educational status	Health vocational high school	5	3.6
	Associate degree	27	19.4
	University	72	51.8
	Master or doctorate	35	25.2
Occupation	Perioperative nurse	109	78.4
	Surgeon	16	11.5
	Other****	14	10.1
Time in current in OR	6 month-2 years	21	15.1
	3-5 years	18	12.9
	6-8 years	36	25.9
	≥ 9 years	64	46
Weekly working hour	40-48 hours	111	79.9
	≥ 49 hours	28	20.1
Chronic disease status	Yes	27	19.4
	No	112	80.6
Did you develop a chronic disease after you started working in the operating room?	Yes	51	36.7
	No	88	63.3

*Min: Minimum; **Max: Maximum; ***SD: Standard deviation; ****Other: Anesthesiologist, anesthesia technician; OR: Operating Room

Table 2: Distribution of surgical smoke prevention methods according to occupation groups (N = 139).

	Occupation Groups							
Types of protection**	**Perioperative nurse (n = 109)**		**Surgeon (n = 16)**		**Other* (n = 14)**		**Total (N = 139)**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Surgical mask	71	83.5	11	12.9	3	3.5	85	61.6
Aspirator	48	87.3	5	9.1	2	3.6	55	39.9
General ventilation system	34	81.0	4	9.5	4	9.5	42	30.4
Central smoke evacuation system	2	100	-	-	-	-	2	1.4
Room (wall) suction	4	100	-	-	-	-	4	2.9
Portable smoke evacuation system	-	-	-	-	-	-	-	-

*Anesthesiologist, anesthesia technician, **Participants chose more than one method.

Table 3: The relationship between education and the waste gas protocol in surgical smoke protection.

About surgical smoke		Situation of taking precautions to avoid surgical smoke				
		Yes		No		p*
		n	%	n	%	
Have you received training on surgical smoke protection?	Yes (17.3%)	15	62.5	9	37.5	0.64
	No (82.7%)	65	46.76	50	35.97	
Is there a waste gas protocol in the hospital	Yes (10.1%)	8	5.75	7	5.03	0.78
	No (87.8%)	72	51.79	52	37.41	

*Chi-square analysis.

Table 4: Comparison of developing symptoms with distance to operating table (N = 139).

Symptoms**	Frequency		Distance to Operating Table								*p
			< 50 cm		50-100 cm		> 100 cm		Total		
			n	%	n	%	n	%	n	%	
Cough	27.2%	Yes	22	16.4	6	4.5	8	6	36	26.9	0.023
		No	68	50.7	24	17.9	6	4.5	98	73.1	
Headache	64.7%	Yes	58	43.3	19	14.2	9	6.7	86	64.2	0.994
		No	32	23.9	11	8.2	5	3.2	48	35.8	
Eye burning	43.4%	Yes	39	29.1	14	10.4	5	3.7	58	43.3	0.792
		No	51	38.1	16	11.9	9	6.7	76	56.7	
Nausea-vomiting	32.4%	Yes	31	23.1	8	6.0	4	3.0	43	32.1	0.700
		No	59	44	22	16.4	10	7.5	91	67.9	
Weakness	72.8%	Yes	68	50.7	21	15.7	9	6.7	98	73.1	0.614
		No	22	16.4	9	6.7	5	3.7	36	26.9	
Anxiety	16.5%	Yes	16	11.9	4	3.0	2	1.5	22	16.4	0.829
		No	74	55.2	26	19.4	12	9.0	112	83.6	

*Chi-square analysis; **Participants chose more than one method.

Table 5: Comparison of data on surgical smoke (N = 139).

Variables		Chronic disease that developed after starting to work in the operating room				
		Yes		No		p*
		n	%	n	%	
Gender	Female	45	42.1	62	57.9	0.01
	Male	6	18.8	26	81.2	
Weekly working hour	40-48 hours	45	40.5	66	59.5	0.61
	> 49 hours	6	21.4	22	78.6	
Time in current in OR	6 month-2 years	6	27.3	16	72.7	0.17
	3-5 years	4	22.2	14	77.8	
	6-8 years	12	33.3	24	66.7	
	> 9 years	29	46	34	54	

*Chi-square analysis; OR: Operating Room.

After starting to work in the operating room, it was determined that the frequency of chronic disease development was higher in women than in men, and the difference between them was significant ($p < 0.05$), but there was no difference in the rates of development of chronic diseases according to the weekly working hours and working time in the operating room ($p > 0.05$) (Table 5).

Discussion

The use of high-frequency electric current to cut or coagulate tissue during electrosurgery causes cellular fluid to evaporate and disperse into the air [17]. It is known that 80% of the small chemical particles released during tissue dissection are harmful, and if inhaled, they pass through the alveolar membrane to the circulatory system, lymphatic system, and distant

organs. Therefore, it is stated that surgical smoke causes headache, eye, and mucosal irritation, and harmful effects especially on the respiratory system [2,11,12,16]. In studies based on the effects of surgical smoke, it has been reported that smoke has infectious, mutagenic, and carcinogenic effects. For this reason, it is essential for health professionals to know and use surgical smoke protection methods for health professionals [3,18].

In the study of Steege, et al. when the reports of the participants regarding surgical smoke were examined, it was found that 44% did not receive any training, 40% did not know whether there was a standard procedure in the hospital where they worked, 75% used general ventilation, 96% never used an aspirator, and 39% did not take any precautions for eye protection [19]. In similar studies conducted in our country, it has been determined that the rate of health professionals working in the operating room to receive training on surgical smoke and to have a protocol for the waste gas management of hospitals is low [15,20,21]. It is reported that standard surgical face masks do not provide effective protection in surgical smoke protection, while portable evacuation devices are the best method of protection [22]. In the study on protection from surgical smoke that occurs during live surgery, it was determined that the protection of a double layer surgical mask is higher than a single layer [23]. Similar to the studies, it was determined in this study that the majority of the participants did not receive any training on surgical smoke, they reported that there was no hospital waste gas protocol at a high rate, the most frequently used method for protection from surgical smoke was surgical masks, and the portable smoke evacuation system was not used (Table 2 and Table 3).

The effects of surgical smoke on health and comfort are a growing concern for the occupational health and safety of team members [18,24,25]. In the studies, it is emphasized that volatile organic compounds in surgical smoke are at a level that threatens the health, that surgeons and sterile nurses are exposed to surgical smoke at a high rate during the operation period due to their distance from the operating table less than five meters, and that they are the group most affected by surgical smoke [19,26,27].

It has been reported in the literature that volatile organic compounds (toluene, xylene, aldehyde, etc.) emerging as a result of surgical smoke cause eye and nose irritation, headache, coordination disorder, nausea, congestion, asthma attacks, and skin problems [4,19]. It has been reported that surgical smoke-related symptom notifications of surgeons working in the operating room are headache (58%), problems with lacrimation (42%), and cough (20%) [22]. In the study of Usta, et al. it was reported that headache (61.9%), burning in the eye (54.3%), cough (41%), and nausea (39%) were among the most common symptoms [28]. In this study, it was observed that the most common post-operative symptoms in healthcare workers were fatigue, headache, burning in the eyes, and cough; and that the incidence of symptoms was higher in those who were closer to the table, and the result was consistent with the literature (Table 4).

Although studies demonstrating the negative effects of surgical smoke are limited, prolonged exposure to surgical smoke is reported to cause acute and chronic diseases [22,24,29]. Alveolar congestion, interstitial pneumonia, emphysematous changes are seen as a result of the accumulation of particles in pulmonary tissue by inhalation of surgical smoke [30]. International organizations have revealed that smoke exposure is associated with heart diseases and bronchospastic lung diseases, and is an important risk factor for cardiovascular mortality, especially in postmenopausal women [31,32]. In this study, it was determined that one-third of the participants developed chronic diseases after they started working in the operating room, and this rate was higher in women than in men. The study found, which showed that the incidence of chronic disease was higher in women after starting work in the operating room, suggested that other risk factors specific to the female gender may also be effective in addition to exposure to surgical smoke. Although the difference in this study was not significant, the chronic disease development rate was found to be higher after starting to work in the operating room in those with the highest working time in the operating room. Since the exposure time to surgical smoke and other risk factors will increase as the working year increases in the operating room, it is expected that the incidence of chronic diseases will be higher in those who have a high working time in the operating room.

Limitations of Study

The study does not provide more detailed information on surgical smoke prevention behavior based on type of surgery or duration of exposure to surgical smoke.

Conclusion and Recommendations

It was determined in the study that the majority of health professionals did not receive training on surgical smoke and did not use an effective prevention method. It is important to know effective methods and to raise awareness on the subject to protect against the harmful effects of surgical smoke. In this sense, it may be recommended to provide training periodically to the operating room team members on the prevention of surgical smoke before and after serving in this unit.

Ethics Committee Approval

The approval of the Clinical Studies Ethics Committee of İstanbul University Cerrahpaşa Medicine Faculty (decision number 259452 dated 18/07/2016) and the written permission from hospital, where the study data were collected were obtained before commencing the study.

Acknowledgment

We would like to thank all the participants in the research.

Conflict of Interests

Authors have no conflict of interest.

Funding

There are no financial supports.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

References

1. Can ÖS, Ökten F (2004) Operasyon Odasında Çalışma Riskleri. Turkiye Klinikleri J Anest Reanim 22: 103-112.
2. Okoshi K, Kobayashi K, Kinoshita K, Tomizawa Y, Hasegawa S, et al. (2015) Health risks associated with exposure to surgical smoke for surgeons and operation room personnel. Surg Today 45: 957-965.
3. Dobbie MK, Fezza M, Kent M, Lu J, Saraceni ML, et al. (2017) Operation clean air: Implementing a surgical smoke evacuation program. Aorn Journal 106: 502-512.
4. Centers for Disease Control and Prevention (CDC). NIOSH Health Hazard Evaluation Report 2006.
5. Centers for Disease Control and Prevention (CDC). NIOSH Study finds healthcare workers' exposure to surgical smoke still common.
6. Ball KA (2010) Surgical smoke evacuation guidelines: Compliance among perioperative nurses. Aorn J 92: 1-23.
7. Hill DS, O'Neill JK, Powell RJ, Oliver DW (2012) Surgical smoke-a health hazard in the operating theatre: A study to quantify exposure and a survey of the use of smoke extractor systems in UK plastic surgery units. J Plast Reconstr Aesthet Surg 65: 911-916.
8. Georgesen C, Lipner SR (2018) Surgical smoke: Risk assessment and mitigation strategies. J Am Acad Dermatol 79: 746-755.
9. Liu Y, Song Y, Hu X, Yan L, Zhu X (2019) Awareness of surgical smoke hazards and enhancement of surgical smoke prevention among the gynecologists. J Cancer 10: 2788-2799.
10. Li CI, Pai JY, Chen CH (2020) Characterization of smoke generated during the use of surgical knife in laparotomy surgeries. J Air Waste Manag Assoc 70: 324-332.
11. Le Moual N, Varraso R, Zock JP, Henneberger P, Speizer FE, et al. (2013) Are operating room nurses at higher risk of severe persistent asthma? J Occup Environ Med 55: 973-977.
12. Fan JKM, Chan FSY, Chu KM (2009) Surgical smoke. Asian J Surg 32: 253-257.
13. Daggett C, Daggett A, McBurney E, Murina A (2020) Laser safety: The need for protocols. Cutis 106: 87-92.
14. Meydanlıoğlu A (2013) Health and safety of health care workers. Balıkesir Health Sciences Journal 2: 192-199.
15. Ünver S, Topçu SY, Fındık ÜY (2016) Surgical smoke, me and my circle. International Journal of Caring Sciences 9: 697-703.
16. Mathias JM (2015) Hiding in plain sight: Surgical threatens health of OR staff. OR Manager 31: 1-4.
17. Lindsey C, Hutchinson M, Mellor G (2015) The nature and hazards of diathermy plumes: A review. AORN J 101: 428-442.
18. Mowbray N, Ansell J, Warren N, Wall P, Torkington J (2013) Is surgical smoke harmful to theater staff? A systematic review. Surg Endosc 27: 3100-3107.
19. Steege AL, Boiano JM, Sweeney MH (2016) Secondhand smoke in the operating room? Precautionary practices lacking for surgical smoke. Am J Ind Med 59: 1020-1031.
20. Yavuz M, Kaymakçı Ş, Özşaker E, Dirimeşe E, Okgün A (2010) Surgical smoke risks in operating rooms and investigation of measures taken.
21. Okgün Alcan A, Yavuz van Giersbergen M, Tanıl V, Dinçarslan G, Hepçivici Z, et al. (2017) Investigation of surgical smoke risks and preventive measures in an university hospital. Journal of Ege University Nursing Faculty 33: 27-35.
22. Addley S, Quinn D (2019) Surgical smoke-what are the risks? TOG 21: 102-106.
23. Tan W, Zhu H, Zhang N, Dong D, Wang S, et al. (2019) Characterization of the PM2.5 concentration in surgical smoke in different tissues during hemihepatectomy and protective measures. Environ Toxicol Pharmacol 72: 103248.
24. Brace MD, Stevens E, Taylor SM, Butt S, Sun Z, et al. (2014) The air that we breathe: Assessment of laser and electrosurgical dissection devices on operating theater air quality. J Otolaryngol Head Neck Surg 43: 39-48.
25. Occupational Safety and Health Administration (OSHA).
26. Choi DH, Choi SH, Kang DH (2016) Influence of surgical smoke on indoor air quality in hospital operating rooms. Aerosol Air Qual. Res 17: 821-830.
27. Romano F, Gustén J, De Antonellis S, Joppolo CM (2017) Electrosurgical smoke: Ultrafine particle measurements and work environment quality in different operating theatres. Int J Environ Res Public Health 14: 137.
28. Usta E, Aygin D, Bozdemir H, Uçar N (2019) The effect of surgical smoke in operating rooms and precautions for protection. Arch Health Sci Res 6: 17-24.
29. Miller KA, Siscovick DS, Sheppard L, Shepherd K, Sullivan JH, et al. (2007) Long-term exposure to air pollution and incidence of cardiovascular events in women. N Engl J Med 356: 447-458.
30. Swerdlow BN (2020) Surgical smoke and the anesthesia provider. J Anesth 34: 575-584.
31. Limchantra IV, Fong Y, Melstrom KA (2019) Surgical smoke exposure in operating room personnel: A review. JAMA Surg 154: 960-967.
32. Brook RD, Rajagopalan S, Pope CA, Brook JR, Bhatnagar A, et al. (2010) Particulate matter air pollution and cardiovascular disease: An update to the scientific statement from the American Heart Association. Circulation 121: 2331-2378.