

Original Research Article

## Investigation of Surgical Smoke Symptoms and Preventive Measures in Turkish Operating Rooms

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### ABSTRACT

**Background:** Operating room nurses are routinely exposed to surgical smoke which causes a range of adverse health symptoms and effects.

**Objective:** The objective of this descriptive study was to investigate surgical smoke symptoms and preventive measures in Turkish Operating Rooms.

**Methods:** The sample of this descriptive study comprised 672 operating room nurses who attended Turkish Surgical and Operating Room Nurses Association's scientific meetings. For data collection, a survey was developed by the researchers in accordance with the related literature of. In the survey contained a total of 41 questions determining socio-demographic data as well as the symptom experiences related with surgical smoke and surgical smoke control measure practices.

**Results:** It was determined that 73.2% (n:492) of the nurses had at least one symptom related to surgical smoke exposure. The Operating Room nurses most suffer from acute and chronic inflammatory respiratory changes (57.3%), headache (51.2%), nausea or vomiting (39.1%) and hypoxia or dizziness (34.1%). Only 8.2% (n: 55) nurses indicated that the institution which they are working have protocols for surgical smoke. 65.0% Of the nurses indicated that they use surgical masks to protect themselves against surgical smoke.

**Conclusions:** As a result, it was found that preventive measures in the operating rooms are inadequate and Turkish operating room nurses have adverse symptoms caused by surgical smoke.

**Key words:** Surgical smoke, operating room nursing, occupational exposure

### INTRODUCTION

Surgical smoke is produced by electrosurgical, laser and ultrasonic devices as a result of disruption and vaporization of tissue protein and fat. The content and the hazardous effect of the surgical smoke vary widely, depending on the nature and pathology of the treated tissue and the exposure time. Numerous studies have established the presence of hazardous components in surgical smoke and these

components could cause a range of adverse health symptoms and effects on surgical team members and patients. [1-7]

Operating Room (OR) nurses are routinely exposed to surgical smoke during daily surgical work. The inhalation of aerosols during electro surgery can cause a range of adverse health symptoms and effects. For several decades, health care workers have been aware of the surgical smoke hazards. [4,6] However, researchers

investigating preventive measures of surgical smoke, perceived hazards and any adverse events OR nurses have experienced in Turkey is lacking. The aim of this study was to investigate surgical smoke risks and preventive measures in Turkish operating rooms.

### Statement of Significance to Nursing

Operating room nurses play an essential role in managing safe surgical environment for both patients and surgical team members. Although there are many evidence-based guidelines to prevent surgical smoke exposure, surgical team and patients still inhale surgical smoke.<sup>[5,8,9]</sup> The results of this study provide information of Turkish OR nurses experiences about surgical smoke exposure and prevention measures.

### LITERATURE REVIEW

Surgical personnel are exposed to a variety of hazardous substances, including potentially infectious agents present in surgical smoke during the course of their career.<sup>[10]</sup> Surgical smoke is the airborne byproduct generated by the use of energy-based instruments such as mono- and bipolar diathermy (electrocautery), ultrasonic scalpels and lasers in operating theaters.<sup>[11]</sup> Energy transferred to cells during laser and electrosurgery leads to heat generation. This heat causes burning and vaporizing of tissues called surgical smoke. Besides creating an offensive odour, surgical smoke contains water, blood, tissue, potentially infectious microorganisms and over 80 various potentially hazardous chemicals.<sup>[2]</sup> This smoke is composed of chemicals, blood and tissue particles, viruses, bacteria and it can be seen, also smelled.<sup>[12]</sup> Bacteria and virus cells in surgical smoke can remain viable for up to 72 hours.<sup>[10]</sup> As the particulate size increases, it acts as a vector for pathogen transmission and travels up to 1 meter from the working area in OR.<sup>[12]</sup> Therefore, surgical smoke causes hazardous health effects on the patient and OR staff.

<sup>[1,2,5,7,9,12,13]</sup> In addition, people spending 50% or more of their time close to the operating theatre indicated more symptoms than others.<sup>[12]</sup>

Laser and electrosurgery devices are widely in use in recent decades. The Occupational Safety and Health Administration (OSHA) reported that approximately 500,000 healthcare workers are exposed to surgical smoke each year.<sup>[14]</sup> Therefore, surgical smoke is one of the major concerns for patients and OR staff. It is known that surgical smoke consists 95% water and 5% toxic components.<sup>[10]</sup> Hill et al. (2012) estimated that exposure to surgical smoke is similar with cigarette smoking. Chronic exposures to these components lead adverse health effects such as acute and chronic respiratory changes, hepatitis, carcinoma, human immunodeficiency virus, human papilloma virus, cardiovascular dysfunction, confusion, nausea, vomiting, headache, sneezing, dermatitis, lacrimation, colic, anxiety and anemia.<sup>[8,9,15]</sup> Concerns have been raised regarding the infectivity, mutagenicity, and cytotoxicity of surgical smoke from all the energy-based instruments.<sup>[11]</sup>

### MATERIALS AND METHODS

The sample of this descriptive study comprised 672 operating room nurses who attended Turkish Surgical and Operating Room Nurses Association's scientific meetings. A sampling method was not used; all the OR nurses who agreed to participate, were included within the scope of the research. Data were collected during the scientific meetings of Turkish Surgical and Operating Room Nurses Association. Turkish Surgical and Operating Room Nurses Association gives scientific educations related with "Surgical Smoke" regularly. The data collection was done prior to association's meetings about Surgical Smoke which were conducted in the cities of Istanbul, Ankara, Izmir, Bolu and Adana. The nurses were asked to respond the survey at a convenient time

before the scientific meetings. Completing the survey took approximately 8-10 minutes.

For data collection, a survey was developed by the researches in accordance with the related literature of [1,2,5,8,11,16]. A pilot application was conducted with 10 nurses to test the clarity, comprehensibility, and functionality of the questions. Any necessary change was made, and the form was then updated. After all the survey contained a total of 41 questions determining socio-demographic data as well as the symptom experiences related with surgical smoke and surgical smoke control measure practices.

### Research Questions

- Do Turkish OR nurses suffer from adverse effects of surgical smoke?
- What are the preventive measures against surgical smoke in Turkish OR's?

### Statistical analysis

Data obtained from this research were analyzed using Statistical Package for the Social Sciences (SPSS) for Windows 16.0 software. Descriptive statistics were presented as number, percentage and mean. Compliance of quantitative variables with the normal distribution was assessed by Kolmogorov Smirnov test. As for the variables that were not normally distributed, Mann Whitney U test was used. The resulting p value at <0.05 was considered statistically significant.

### Ethical considerations

Written permission to conduct the research was obtained from the Ege University Faculty of Nursing Ethics

Committee as well as the board of Turkish Surgical and Operating Room Nurses Association. The purpose and details of the study were explained to the nurses and oral consent was provided by all participants.

## RESULTS

The average age of the 672 OR nurses included in the study was 34.50±7.39 years (range, 19-58 years), their average length of work in the profession was 14.13± years (range, 1-37 years), and their average length of work in operating room was 10.00±7.76 years (range, 1-35 years). Of the 672 OR nurses, 92.9% (n:624) were female and 7.17% (n:48) were male, 15.0% (n:101) had a health vocational high school degree, 30.2% (n:203) had associated degree, 48.7% (n:327) had a bachelor's degree and 6.1% (n:41) had a graduate degree. 54.8% (n:247) Of the respondents were working in public hospitals, 36.8% (n:247) were working in university hospitals and 8.5% (n:57) were working in private hospitals. The practice areas in which they work are shown in Table 1.

**Table 1: Practice Areas Presented by Operating Room Nurses**

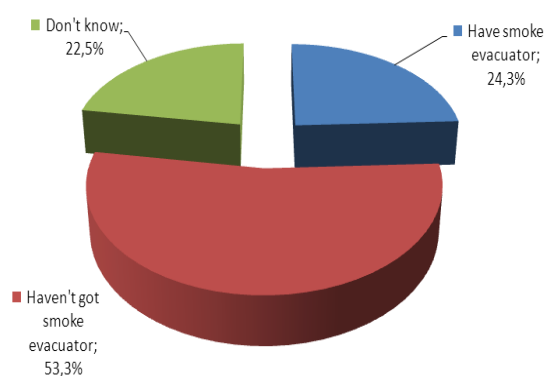
Practice Area	Number	Percentage
Central Operating Room	241	35.9
General Surgery	166	24.7
Thoracic and Cardiovascular Surgery	66	9.8
Orthopedics and Traumatology	42	6.3
Urology	38	5.7
Obstetrics and Gynecology	32	4.8
Neurosurgery	29	4.3
Ophthalmology	21	3.1
Otorhinolaryngology	20	3.0
Plastic and Reconstructive Surgery	14	2.1
Outpatient surgery	3	0.4

**Table 2: The symptoms and potential risks of surgical smoke indicated by OR nurses**

The Symptoms and Potential Risks	Number n	Percentage %	The Symptoms and Potential Risks	Number n	Percentage %
Respiratory changes	385	57.3	Weakness	137	20.4
Headache	344	51.2	Conjunctivitis	128	19.0
Nausea/Vomiting	263	39.1	Anemia	88	13.1
Hypoxia/dizziness	229	34.1	Abdominal pain	87	12.9
Lacrimation	202	30.1	Dermatitis	84	12.5
Throat irritation	192	28.6	Cardiovascular dysfunction	71	10.6
Sneezing	188	28.0	Nasopharyngeal lesions	64	9.5
Temper	174	25.9	Carcinoma	23	3.4
Hair smell	160	23.8	Hepatitis	20	3.0
Myalgia	141	21.0			

This study showed that 73.2% (n:492) of the nurses had at least one symptom because of surgical smoke. Acute and chronic inflammatory respiratory changes (57.3%), headache (51.2%), nausea or vomiting (39.1%) and hypoxia or dizziness (34.1%) are the symptoms and potential risks which are indicated mostly by the OR nurses. The other symptoms and potential risks of surgical smoke indicated by OR nurses participated in this study are shown in Table 2.

According to this study it was found that length of working in OR doesn't affect the status of having surgical smoke symptom (U:42446.5 p:0.410 p>0.05). Besides, statistically significant differences were found between length of working in OR and nausea or vomiting (U:46906.0 p:0.005 p<0.05), conjunctivitis (U:29858.0 p:0.012 p<0.05), hair smell (U:36019.0 p:0.021 p<0.05), hepatitis (U:4760.5 p:0.039 p<0.05), throat irritation (U:41243.0 p:0.033 p<0.05), anemia (U:24548.0 p:0.014 p<0.05), lacrimation (U:41570.5 p:0.010 p<0.05). OR nurses who suffered from these symptoms have longer length of service in OR than others.

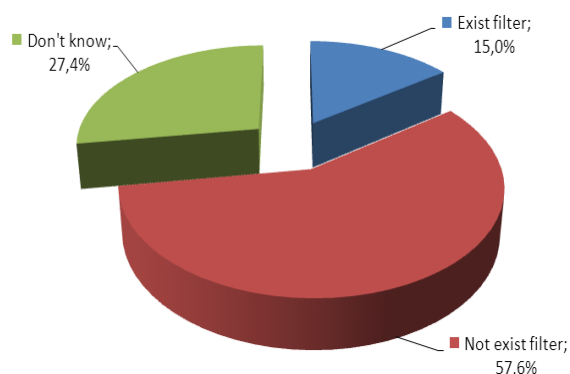


Graphic 1: Having Smoke Evacuators in the OR

As shown in Graphic 1, only 24.3% (n:163) respondents indicated that there are smoke evacuators in the OR which they are working in. 81.0% (n:132) Of the nurses who indicated that they have smoke evacuators in their working place mentioned that the devices are used actively. The OR nurses stated that refusal to allow smoke evacuation is usually a reflection of lack of

knowledge (52.3%), high cost of device (20.3%), the believe that standard surgical masks provide adequate protection (9.8%), the concerns of surgeon's that the device decreases their eye-hand coordination, lack of staff (6.3%) and excessive noise (5.9%).

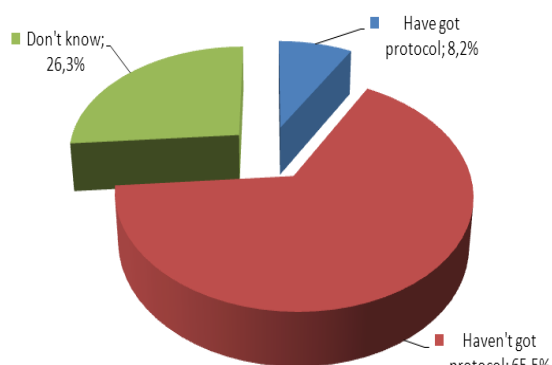
In this study; only 15.0% (n:101) of the nurses stated that filters are existed on the instruments produce surgical smoke (Graphic 2).



Graphic 2: Status of Filter Existing on the Instruments Produce Surgical Smoke

OR nurses stated that central smoke evacuation (15.9%), portable smoke evacuation (3.3%) and wall suction tubing systems (3.3%) are used for prevention of surgical smoke. Also, nurses indicated that they use personal protection equipments such as surgical masks (65.0%), gloves (40.3%), glasses (38.7%), gowns (37.5%) and filtration masks (11.5%) to protect themselves from surgical smoke.

As shown in Graphic 3, only 8.2% (n:55) of the respondents indicated that their institution have protocols for surgical smoke.



Graphic 3: Status of Having Protocol for Surgical Smoke

## DISCUSSION

The purpose of this descriptive study was to investigate surgical smoke symptom and preventive measures in Turkish operating rooms.

There are few research studies that showed surgical smoke to harm health care professionals and patients. Because it is very difficult to verify a direct connection between surgical smoke and identifiable cases of health problems. But it is generally accepted that surgical smoke has hazardous effects to both patients and surgical team. Because surgical smoke contains chemical products which is occurred by burning of proteins and lipids during electro surgery. Studies have shown that these chemical products cause various symptoms and potential long term adverse effects. [1,3,6] In the current study, surgical smoke symptoms were prevalent for OR nurses, as they reported acute and chronic inflammatory respiratory changes, headache, nausea or vomiting, hypoxia or dizziness, lacrimation, throat irritation, sneezing, temper, hair smell, myalgia, weakness, rhinitis, conjunctivitis, anemia, colic, dermatitis, cardiovascular dysfunction, nasopharyngeal lesions, carcinoma and hepatitis. These results concur with other findings in the literature which investigated potential hazards of surgical smoke. Ball et al. (2010) stated that OR nurses suffer from twice as much respiratory problems than general population due to cumulative exposure to surgical smoke. [8] In the literature the potential surgical smoke risks to OR personnel are determined as pulmonary irritation and inflammation, transmission of infection, headache, fatigue, eye irritation and genotoxicity. [1,6,9,17] Okgun Alcan et al. (2017) determined that 87.3% of OR nurses included in the survey had at least one symptom related to surgical smoke. It was found that the operating room nurses most suffer from headache (71.8%), nausea (63.4%) and coughing (57.7%) related with surgical smoke exposure. [17] Similarly, Ilce et al. (2017) stated that OR nurses and doctors experienced headache, lacrimation,

cough, sore throat, hair smell, nausea, drowsiness, sneezing and rhinitis due to exposure to surgical smoke. [15] There are also studies which reported that infectious diseases such as HIV and hepatitis can be spread via surgical smoke. Although HIV is not reported by the participants in this study, nurses complained about other adverse effects of surgical smoke. These reports confirm our findings.

Of the many factors associated with hazardous effects of surgical smoke, duration of exposure is an important factor that should be considered. It was found that nurses working for a long period in the OR suffer from nausea or vomiting, conjunctivitis, hair smell, hepatitis, throat irritation, anemia and lacrimation more than others. It is reported that the harmful effects of exposure to surgical smoke depends on the duration. [18]

When working in the OR during smoke generating procedures, potentially dangerous and infectious debris and contaminants that could cause adverse health effects are being released into the atmosphere. [10] AORN, the Joint Commission, the American National Standards Institute, the Laser Institute of America all these institutions and each recommend that surgical smoke be filtered and evacuated through the use of room ventilation and local exhaust ventilation methods. [10,11] Decreasing hazards of surgical smoke and smoke evacuation devices have not been used routinely and consistently in many ORs. [12] This study identified some deficiencies in the usage of preventive measures against surgical smoke. These deficiencies also result in surgical smoke symptoms. Respondents indicated a lower frequency of use of smoke evacuators during the procedures against surgical smoke. Several studies have indicated that health care workers are inconsistent with and have suboptimal adherence to recommended surgical smoke precautions. [8] Edwards and Reiman (2008) stated that many facilities have not implemented best practices for protecting patients and health



care workers from surgical smoke hazards, especially smoke created during electrosurgical, electrocautery, and diathermy procedures. [4] Ilce et al (2017) stated that a few OR nurses reported that they used a central smoke evacuation system. [15] Similarly, Okgun Alcan et al.(2017) determined that 97.2% of OR nurses evaluated the measures taken against surgical smoke prevention in the operating rooms which they work in, as inadequate. [17] Smoke evacuation still has not become standard in many settings, and because of the lack of appropriate smoke evacuation systems, surgical smoke is still an ongoing problem. [12]

In the literature reasons of refusing usage of smoke evacuation are pointed out as: the concern that an altered protocol could negatively affect the surgical result, anxiety associated with any change to routines, a lack of knowledge about sources that recommend the removal of smoke, lack of management support, distraction caused by the noise generated by the smoke evacuator, unavailability of devices that achieve high efficiency capture, devices that require the surgeon's involvement, bulkiness, getting in the way, high costs, not recognizing surgical smoke as a hazard, not having enough staff to hold suction inlets. [4,15,19,20] The obstacles to use smoke evacuators are reported as lack of knowledge, high cost of device, the believe that standard surgical masks provide adequate protection, surgeons' concerns about device decreases their eye-hand coordination, lack of staff and an excessive noise by participants. In this respect our results are resumable with the literature.

Standard surgical masks are designed to protect healthcare professionals from microorganisms and aerosolized body fluids in the operating room. However only large droplets or particles (>5 microns) are blocked. Therefore, they do not provide adequate protection in filtering surgical smoke. [7,9,16] Nevertheless most of the OR nurses participated in this study erroneously feel that standard surgical masks protect

themselves from surgical smoke exposure. It is recommended using high performance filtration masks to provide greater protection against surgical smoke. But majority of OR nurses indicated that they do not use filtration masks. These results are similar with Edwards and Reiman's results (2008) showing that very few nurses routinely use effective respiratory protection for surgical smoke. [4] Similarly Ilce et al. (2017) reported that majority of the OR nurses and surgeons used the surgical masks for prevention against surgical smoke. [15]

The other important finding of this study is that too few healthcare institutions have got protocols against surgical smoke. Similarly, Ilce et al. (2017) found that most of the OR nurses and surgeons reported that their institutions haven't got a protocol against surgical smoke prevention. There are no mandatory regulations in Turkey against surgical smoke but there are voluntary standards from professional organizations protocols.

## CONCLUSION

These results suggest that Turkish OR nurses are not adequately protected from exposure to surgical smoke and they have adverse symptoms because of surgical smoke. Although these results provide an interesting snapshot of surgical smoke management in Turkey, they also indicate that much work remains to be done.

As a result, it was found that effective engineering controls for surgical smoke in the operating rooms are inadequate and the Turkish operating room nurses have adverse symptoms because of surgical smoke.

As a result of this study, we recommend that health care managers should assess the potential dangers of surgical smoke, educate the OR staff about these dangers and encourage the use of evacuation devices to minimize potential health hazards to surgical personnel.

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**Conflict of Interest:** The authors declare that they have no conflict of interests.

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