



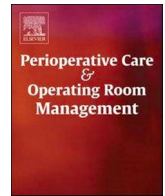
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# Perioperative Care and Operating Room Management

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## Knowledge about the effects of electrosurgery smoke among operating room nurses during COVID-19 Pandemic: A Cross-Sectional Study

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### ABSTRACT

**Background:** Electrosurgery smoke is the smoke emitted from tissue cauterization when using the electrosurgery device. Accordingly, in this smoke, more than 80 harmful toxins have been discovered. In the current study, we aimed to investigate the level of knowledge reported by the operating room nurses on the effects of electrosurgery smoke during the current COVID-19 pandemic.

**Methods:** This descriptive, survey-based cross-sectional study was performed on 533 OR nurses in all the referring hospitals of COVID-19 infection. The required information were collected using a questionnaire regarding the knowledge on the side effects of electrosurgery smoke. The obtained data were then analyzed using *t*-test and ANOVA by SPSS software.

**Results:** Most of the included participants (93.6%) had a low level of awareness and only a small number of them (0.4%) had a good level of knowledge on the effects of electrosurgery smoke. As well, a significant relationship ( $P < 0.05$ ) was found between the level of knowledge reported by the OR nurses and the type of hospital (educational or private). Most of the studied hospitals used no electrosurgery smoke reduction equipment during electrosurgery.

**Conclusion:** The level of knowledge reported by the OR nurses was generally poor. It is recommended that managers and health officials try to increase the level of awareness of OR nurses during the COVID-19 pandemic by providing standard and protective equipment as well as holding some well-organized and related training courses.

### 1. Introduction

The electrosurgery device is among the most widely used equipment during surgery.<sup>1</sup> The unique features of this device make it an integral part of each surgery.<sup>2,3</sup> In electrosurgery, high frequency is used either for cutting tissues or for coagulation.<sup>4</sup> Providing homeostasis during any surgery, creating a bloodless position, and thus obtaining a better vision of the surgical team than the surgical field are the other advantages of this device.<sup>5</sup> In this regard, the vapor produced by tissue coagulation using an electrosurgery device is called electrosurgery smoke.<sup>6</sup> Numerous studies have previously reported more than 80 types of toxins in electrosurgery.<sup>7-10</sup> Moreover, a direct link was found between the effects of this smoke and some physical complications such as

headaches, both acute and chronic respiratory diseases, skin inflammation, eye diseases, gastrointestinal diseases, bacterial and viral infections, and possibly COVID-19 virus.<sup>11,12</sup> According to the reports of the Occupational Health and Safety Organization, 500,000 surgeons, anesthesiologists, and operating room nurses are annually exposed to surgical smoke.<sup>13</sup> Some studies have shown that the exposure to electrosurgery smoke for one day is equal to smoking between 27 and 30 unfiltered cigarettes. As well, inhaling the smoke produced when using an electrosurgery device to burn tissue is equal to smoking six unfiltered cigarettes in just 15 minutes.<sup>14,15</sup> Under the sensitive and critical pandemic conditions of the COVID-19 virus, the American College of Surgeons and the World Health Organization have recommended that surgeons should minimize those actions producing aerosols and particles

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in the operating room. Since electrosurgery and the subsequent smoke spread these particles in the OR when cutting the internal tissues of a patient with COVID-19 infection, so other cutting devices should be used instead of using the electrosurgery device. Otherwise, besides the risk of developing the above-mentioned diseases, there still is a possibility of spreading the COVID-19 virus among the members of the surgical team. However, because of the lack of information in this regard, this issue has not been fully determined yet.<sup>16-18</sup> It was indicated that increasing the awareness of OR nurses on the effects of electrosurgery smoke and its associated diseases can reduce such diseases and the related complications, especially during the COVID-19 pandemic. Therefore, in the current study, we aimed to examine the level of knowledge reported by the OR nurses on the side effects of electrosurgery smoke.

## 2. Material and methods

This cross-sectional study was performed using the census method in the OR of all the referring hospitals of COVID-19 infection in Shiraz (with the largest referral hospitals in southern Iran) between March 5 and July 21, 2020. In this study, firstly, the list of the OR nurses was obtained from the head nurse by referring to the hospitals admitting patients with COVID-19 infection. Thereafter, the questionnaires were distributed by the researchers among the OR nurses in the morning, evening, and at night shifts. After the questionnaires' completion, they were matched with the number of OR nurses mentioned in the list. The response rate of the included participants was estimated as 73%. Of the total 730 OR nurses in teaching and private hospitals, 533 subjects who met the inclusion criteria (including having at least an associate degree and at least six months of experience in the OR) were selected. The only exclusion criterion was unwillingness to participate in the study. Before performing the study, the researchers informed the study participants on the objectives of the study by entering the research setting (OR of the hospitals admitting patients with COVID-19 infection) as well as reassuring the participants about the confidentiality of their information. Of note, at the next stage, by signing a written consent form, the participants gave their consents to participate in this study. The current study was designed based on the STROBE guidelines for observational studies. Thereafter, the required information were collected by a questionnaire regarding the OR nurse's knowledge on the effects of electrosurgery smoke. Accordingly, this questionnaire consisted of the following two parts: the first section contained demographic information, including sex, work experience, educational level, and type of hospital. Work experience, as a continuous variable, was divided into four age groups of 0-5, 6-10, 11-20, and 21-30 years old. Additionally, the second part of the questionnaire consisted of 21 multiple choice questions examining the participants' knowledge on electrosurgery smoke (its compounds, transmission rate, and harms). The scoring of the questionnaire was performed based on grading (yes: scored as 1, no and I do not know: scored as 0). The total score of the questionnaire was then obtained from the sum of the total scores of the questions, which ranged from 0 to 21. Finally, in order to measure the level of knowledge of the participants included in this study, the questionnaire result was divided into three levels of poor knowledge (scores less than 50%, total scores of 0 to 10), moderate knowledge (scores between 51 and 75%, total scores of 11-16), and a good knowledge (scores greater than 75%, total scores of 17 to 21).<sup>19</sup> In 2014, Khoshdel et al. used content validity to validate the questionnaire as well as the test-retest method to assess its reliability. Accordingly, its correlation coefficient was 0.87 and the reliability coefficient of the questionnaire was estimated as 80% using Cronbach's alpha coefficient.<sup>19</sup> The obtained data were analyzed by SPSS software, version 18. Correspondingly, descriptive tests were used to assess the level of awareness and *t* and ANOVA tests were used to determine the relationship between awareness and demographic variables. Of note,  $P < 0.05$  was considered as statistically significant.

### 2.1. Ethical considerations

This study was approved by the Institutional Review Board Shiraz university of medical Science (ethical code: IR.SUMS.REC.1400.008). All participants agreed to participate in the study and signed an informed consent. The participants were assured that their information would remain confidential.

## 3. Results

In this study, of the total 533 participants, 73% were women. Moreover, most of them had a bachelor's degree and less than five years of work experience, and they were working in teaching hospitals (table 1).

After the data analysis, 93.6% of the OR nurses had a low level of knowledge, 6% of them had a moderate level of knowledge, and only 0.4% had a good level of knowledge. As well, based on the results, the Mean $\pm$ SD level of knowledge reported by the OR nurses on the effects of electrosurgery smoke was 4.82 $\pm$ 3.82 (table 2).

The Mean $\pm$ SD levels of knowledge reported by the OR nurses in both teaching and private hospitals were 3.82 $\pm$ 3.82 and 4.67 $\pm$ 3.77, respectively, indicating a high the level of knowledge reported by the OR nurses among the staff of private hospitals compared to those working in teaching hospitals. By performing statistical analyses between the level of knowledge and demographic characteristics, a significant relationship was only observed between the level of knowledge and the type of hospital ( $P < 0.05$ ). Notably, the level of knowledge in the nurses of private hospitals was found to be more than those people working in teaching hospitals. Additionally, although there was no significant relationship between sex and the level of knowledge reported by the OR nurses, the level of knowledge in women was higher than men (4.1 vs. 3.8). Most of the participants (90.8%) mentioned that there is no equipment for reducing smoke in the OR nurses. Furthermore, 94.7% of the included participants reported that they do not use a mask with high filtration (such as N95) during surgery. The mean, standard deviation, number, and percentage of the correct and incorrect answers to each question are separately shown in table 3.

## 4. Discussion

This study was performed to evaluate the level of knowledge reported by the OR nurses on the effects of electrosurgery smoke and its related physical complications during the current COVID-19 pandemic using a cross-sectional design. As a result, we found that most of the included participants had a low level of awareness and only few of them had a good level of knowledge reported by the OR nurses on the effects of electrosurgery smoke.

In our study, besides teaching hospitals, private hospitals were also evaluated. Thereafter, a significant relationship was observed between the level of knowledge reported by the OR nurses and the type of hospital, so that people working in private hospitals had higher levels of

**Table 1**  
The demographic characteristics of operating room nurses (n=533)

Variable		Frequency (%)
Sex	Female	389 (73%)
	Male	144 (27%)
Educational degree	Master's	33 (6.2%)
	Bachelor's	470 (88.2%)
	College	30 (5.6%)
Work history (years)	0-5	276 (51.8%)
	6-10	110 (20.6%)
	11-20	140 (38.8%)
	21-30	7 (1.3%)
Type of hospital	Educational	402 (75.4%)
	Private	131 (24.6%)

**Table 2**

Level of knowledge of operating room nurses regarding electrosurgery smoke complications

Level of awareness			Mean±SD
Good Frequency (%)	<b>Moderate</b>	<b>Weak</b>	4.03±3.82
2 (0.4%)	32 (6%)	499 (93.6%)	

knowledge than their colleagues working in teaching hospitals. Therefore, the type of hospital was found as another possible reason for the inconsistency between the results of the study by Khoshdel et al. and ours. Since in this study, the level of knowledge reported by the OR nurses was generally poor, so it is recommended that OR officials should enhance the level of knowledge on electrosurgery smoke and complications by holding workshops and training courses in the OR.<sup>19,20</sup>

Moreover, we found that the levels of knowledge on the different aspects of electrosurgery smoke, its transmission, and the related diseases in most of the participants were unexpectedly low. Among the diseases transmitted by such smoke, the risks of developing respiratory diseases; leukemia; gastrointestinal complications; diabetes mellitus; and viral diseases, including hepatitis B (HBV), hepatitis C (HCV), human immunodeficiency virus (HIV), and human papilloma virus (HPV) were reported to be higher.<sup>20-22</sup> Additionally, in a study evaluating the effects of surgical smoke on medical staff, respiratory problems and headaches were identified as the most common symptoms among OR nurses.<sup>23</sup> In another study, the researchers found that HIV, HCV, HBV, and HPV can be transmitted through electrosurgery smoke.<sup>21</sup> Considering the rate of possible infections through electrosurgery smoke, which has been previously reported in various studies, there also are strong concerns on the transmission of COVID-19 virus under the current pandemic conditions. In a review conducted on the transmission of COVID-19 virus through surgical smoke, there was insufficient evidence of the direct transmission of the virus through electrosurgery smoke.<sup>10</sup> Various studies have also identified the transmission of the virus through surgical smoke, and because of the lack of accurate information regarding the transmission of COVID-19 virus through such smoke, adherence to all protection protocols in all operating rooms is critical, in order to minimize the risk of this transmission.<sup>24</sup>

We found that in most of the evaluated hospitals in this study, protective equipment such as electrosurgery smoke suction devices, suction equipped with smoke absorption filtration, and high filtration masks such as N95 were not used during electro-surgeries. The American OR nurses Association and the National Agency for Occupational Health and Safety (NIOSH), stated that having compliance with these safety standards is the primary way to prevent surgical smoke inhalation.<sup>24,25</sup> Moreover, they emphasized that it is the employer's duty to create a safe and smoke-free surgical environment for all OR nurses. However, the main obstacle in using this equipment is probably the lack of sufficient knowledge of hospital managers and officials on this issue.

It was shown that electrosurgery can eventually lead to various diseases, the reduced performance,<sup>26,27</sup> and the increased treatment costs for personnel and the medical system.<sup>28</sup> Therefore, necessary measures should be taken into account to minimize these complications. In this regard, the use of masks with filter,<sup>21,29</sup> smoke suction systems, personal protective equipment, and high-capacity ventilation system<sup>24</sup> have been recommended. Finally, increasing both the knowledge and awareness of OR nurses through holding workshops and training courses are also recommended.<sup>19</sup>

**4.1. Limitations Study**

One of the limitations of the present study is that surgeons and members of the anesthesia team were not included, although these professionals are also in direct contact with electrosurgery smoke. Other limitations of this study include the lack of assessment of participants'

**Table 3**

Level of knowledge of operating room staff about the effects of electrosurgery smoke based on questionnaire items

Row	Items	*Yes Frequency (%)	*No Frequency (%)	Have no idea (%)	Mean ±SD
1	Is electrosurgery smoke a compound of several vapors?	(52.9) 282	(8.4) 45	(38.6) 206	1.30±0.61
2	Are the compounds of electrosurgery smoke dangerous?	(87.2) 465	(3) 16	(9.8) 52	1.07±0.35
3	Can electrosurgery smoke create complications such as emphysema, bronchitis, and nasal problems?	(70) 373	(6.6) 35	125 (23/5)	1.17±0.52
4	Does inhaling electrosurgery smoke create hypoxia and dizziness?	(58.5) 312	(11.8) 63	(29.6)158	1.18±0.61
5	Does contact with the smoke cause dizziness?	281 (52.7)	110 (20.6)	142 (26.6)	1.06±0.68
6	Can exposure to electrosurgery smoke increase the risk of being infected with HIV?	139 (26.1)	220 (41.3)	174 (32.6)	0.91±0.85
7	Does inhaling electrosurgery smoke increase the risk of cancer?	374 (70.2)	40 (7.5)	119 (22.3)	1.15±0.52
8	Does exposure to electrosurgery smoke cause skin problems such as dermatitis?	103 (19.3)	166 (31.1)	264 (41.5)	1.18±0.88
9	Does exposure to electrosurgery smoke cause cardiovascular complications and disorders?	103 (19.3)	137 (25.7)	293 (55)	1.29±0.85
10	Does exposure to electrosurgery smoke cause diabetes?	30 (5.6)	235 (44.1)	268 (50.3)	1.06±0.97
11	Can exposure to electrosurgery smoke cause headaches?	428 (80.3)	33 (6.2)	72 (13.5)	1.07±0.43
12	Can exposure to electrosurgery smoke cause nausea and vomiting?	381 (71.5)	51 (9.6)	101 (18.9)	1.09±0.52
13	Does contact with electrosurgery smoke cause gastrointestinal complications such as ulcerative colitis?	82 (15.4)	135 (25.3)	316 (59.3)	1.34±0.85
14	Can exposure to electrosurgery	98 (18.4)	195 (36.6)	240 (45)	1.08±0.90

(continued on next page)

Table 3 (continued)

Row	Items	*Yes Frequency (%)	*No Frequency (%)	Have no idea (%)	Mean $\pm$ SD
15	smoke increase the risk of contracting hepatitis B? Can contact with electrosurgery smoke cause anemia?	63 (11.8)	186 (39.4)	284 (53)	1.18 $\pm$ 0.92
16	Can exposure to electrosurgery smoke cause leukemia?	112 (21)	125 (23.5)	296 (55/5)	1.32 $\pm$ 0.83
17	Is exposure to electrosurgery smoke effective in fatigue and weakness of the surgical technologist?	383 (71.9)	45 (7.4)	105 (19.7)	1.11 $\pm$ 0.51
18	Does contact with the electrosurgery smoke cause eye problems such as eye irritation and tears?	374 (70.2)	72 (13.5)	87 (16.3)	1.03 $\pm$ 0.54
19	Does eye contact with electrosurgery smoke reduce vision and diplopia?	138 (25.9)	157 (29.5)	238 (44.7)	1.15 $\pm$ 0.84
20	Does contact with electrosurgery smoke cause sore throat?	334 (62.7)	78 (14.6)	121 (22.7)	1.08 $\pm$ 0.60
21	Is exposure to electrosurgery smoke a risk of infection with inhaled viruses such as human papillomavirus and Covid19?	207 (38.8)	103 (19.3)	223 (41.8)	1.23 $\pm$ 0.75

\***(Yes)**, as the correct answer to all the questions.

\***NO**, as the Wrong answer to all the questions.

awareness about the ways one can transmit Covid-19 disease, as well as not taking into consideration factors such as job fatigue and time limitations of the participants who completed the questionnaire.

## 5. Conclusion

According to our results, the level of knowledge reported by the OR nurses on the complications of electrosurgery smoke was found to be generally low. Since the electrosurgery device is an essential equipment in the OR and it is almost impossible to not use it, so necessary measures should be taken into account in order to reduce the complications caused by this smoke, which can lead to various physical complications. Accordingly, it is recommended that managers should establish some programs focusing on reducing the rate of diseases and disorders caused by electrosurgery by providing standard and protective equipment as well as holding classes and training courses, in order to maximize the level of knowledge in this regard.

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## Conflict of interest

The authors declare no conflicts of interest.

## Declaration of Competing Interest

All authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Authors Contribution

**Armin Fereidouni:** Conceptualization, Methodology, draft preparation, Data Collection. **Fatemeh Vizehsfar:** Supervision, Writing - Original draft preparation. **Maryam Ghanavati:** Visualization, Investigation, Software, Data Collection. **Reza Tavakol:** Writing - Reviewing and Editing, Data curation.

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