

**ORIGINAL RESEARCH**

# Protection Adjustments and Safety Changes for Surgical Smoke- Decoding Fear, and Providing Safety among Health Workers

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**ABSTRACT**

**Background:** Providing a safe environment for patients and the operating room staff during postoperative care is essential. The purpose of the study was to determine the operating room team members' understanding of surgical smoke safety. **Methods:** 894 people, including surgeons, anaesthetists, surgical technicians, anaesthesia technicians, and surgical nurses, came forward to participate in the cross-sectional survey. There was a total of 35 questions in the survey that determined socio-demographic data, such as age, gender, occupation, years spent working in the operating room, if there are any diseases present, and symptoms brought on by surgical smoke, as well as surgical smoke prevention techniques, as well as the protocols used regarding where they work and the degree of knowledge about surgical smoke. The data was gathered through in-person interviews. **Results:** The study's participants had an average age of  $34.82 \pm 7.01$  years. It was discovered that 74% of the participants were women, 63.19% were nurses, 47.98% had experience working in an operating room for at least three years, and 81.99% had a monthly work hour of fewer than 200 hours. 82.21% of the sample group were found to be free of chronic illness. It was shown that chronic illness development occurred more frequently (25.06%) once work in the operation room had begun. Headache (59.06%) and Eye discomfort (41.05%) were the two most common health problems experienced by OR healthcare professionals. Majority of the individuals participating in the study did not receive training on surgical smoke and stated that the institution did not have a waste gas protocol. **Conclusions:** To bring the operating room staff's knowledge to a sufficient level and raise their awareness of occupational health and occupational exposure, the institution needs to implement policies, supervise employees, and provide well-designed educational programmes.

**Keywords:** Occupational health, Occupational exposure, Surgical smoke, Plume

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**INTRODUCTION**

The gaseous by-product of surgical procedures, such as laser conization, loop electrosurgical procedures, diathermy, electrocautery, laser ablation/irradiation, electrosurgical excision, ultrasonic (harmonic) excision, and high-speed drilling, sawing, or burring, is known as surgical smoke or plume. Continuous inhalation of surgical smoke can pose concerns for surgeons, nurses, anaesthesiologists, and operators'

room technicians because it contains chemicals, blood and tissue particles, bacteria, and viruses<sup>1</sup>. It is created and discharged into the operational area (OT) conditions during such procedures by the thermal breakdown and vaporisation of tissue components<sup>2</sup>. The device's discernible gaseous by product is referred to as "surgical smoke," and it is primarily made up of 95% water vapour. Particulate pollution is the remaining portion, which includes gases like benzene,

toluene, acetylene, xylene, and hydrogen cyanide that are known teratogens, mutagens, and carriers of live cancer cells, germs, viruses, and blood fragments<sup>3</sup>. A plastic surgery operating room produced the same amount of surgical smoke as 27 to 30 cigarettes. The field of science has shown a growing interest in characterising surgical plume contents as well as the conduct and safety precautions of some OR personnel. While a closed gaseous atmosphere generated during abdominal laparoscopic surgery may cause systemic absorption of hazardous chemicals produced by electrosurgery<sup>4</sup>, researchers and medical professionals are also worried about patient health. Concerns concerning the possibility of virus transmission to operating room employees have been raised by the 2020 pandemic of the new coronavirus COVID-19<sup>5</sup>. The research has shown that operating room nurses have a twofold higher incidence of various respiratory conditions than the general population, including bronchitis, asthma, sinus infections, and allergies.<sup>6</sup>In this situation, a descriptive research was conducted to ascertain the surgical smoke protection status of medical personnel working in operating rooms. Our inquiry for research was:

1. How much is surgical vapour regarded as a physical risk? What are the health risks and preventative actions that operating room staff are aware of?
2. What structural and behavioural preventive safeguards are present in operating rooms of hospitals and outpatient institutions.?
3. How well are current preventive strategies being put into action? What do workers expect from their employers, coworkers, and the manufacturers of technical gear in terms of protection from surgical smoke?

## MATERIALS AND METHODS

The representatives for the descriptive survey includes 894 healthcare professionals, including surgeons, anaesthetists, surgical technicians, anaesthesia technicians, and surgical nurses, who consented to participate in the study and had experience of at least a year working in an operating room between February 2022 and February 2023. Throughout a two-month

period, data were collected. Using G\*Power version 3.1 (Dusseldorf, German) and linear multiple regression, with effect size  $f^2$  of 0.15,  $\alpha$  of 0.05, power of 0.8, the sample size was calculated. The survey took about 8 to 10 minutes to complete. General surgery, gynaecology, plastic surgery, orthopaedic surgery, neurology, and heart surgery were the surgical specialties covered by the survey. The researchers created a survey for data collecting in accordance with the pertinent literature. To assess the questions' clarity, comprehensibility, and functionality, a trial application with 25 health professionals were used. During the pilot study and the present survey, the Cronbach's alphas were 0.85 and 0.89, respectively. The form was then updated when any necessary adjustments were made. In total, there were 35 questions in the survey that determined socio-demographic information, including age, gender, years spent working in the operating room, the presence of any diseases, and symptoms brought on by surgical smoke and surgical smoke prevention techniques, the procedures followed in the workplace and the depth of their understanding of surgical smoke. The data was gathered through in-person interviews.

## STATISTICAL ANALYSIS

Statistical Package for the Social Sciences (SPSS) for Windows 16.0 software was used to analyse the research's data. Number, percentage, and mean were used to show descriptive statistics. By using the Kolmogorov-Smirnov test, quantitative variables' conformity to the normal distribution was evaluated. The Mann Whitney U test was applied to the variables that were not normally distributed. A 0.05 p value was used to determine statistical significance.

## ETHICAL CONSIDERATIONS

An institutional review board's permission was considered unnecessary because no patients were involved. Permission was received by the operating room director and manager of the OR. All participants supplied oral consent after being informed about the study's goals and specifics.

## RESULTS

**Table 1: Demographic features of participants (N= 894)**

Demographic Characters		Min-Max	Mean $\pm$ SD
Age		23-60	34.82 $\pm$ 7.01
		n	%
Gender	Female	661	74
	Male	233	26
Profession	Surgeon	40	4.47
	Surgical nurse	565	63.19
	Anesthetist	61	6.82
	Anesthesia Technician	172	19.23
	Surgical Technician	56	6.26
Duration of being posted in Operating Room	1-2 years	205	22.93
	2-3 years	260	29.08

	> 3 years	429	47.98
<b>Working hours per month</b>	< 200 hours (25 days×8 hours)	733	81.99
	> 200 hours(25 days×8 hours)	161	18.01
<b>History of chronic disease</b>	Yes	159	17.79
	No	735	82.21
<b>Have you developed chronic illness after beginning to work in the operating room or any existing disease gets aggravated?</b>	Yes	224	25.06
	No	670	74.94

The average age of the participants in the study was  $34.82 \pm 7.01$  years. It was discovered that 74% of the survey group was female, 63.19% were a nurse, 47.98% had an experience of 3 years or more in the surgical area, and 81.99% had a monthly working time of less than 200 hours. 82.21% of the study group were found to be free of chronic illness. It was discovered that the frequency of chronic disease development was higher (25.06%) once work in the operation room had begun. (Table 1).

**Table2: The adverse effects of surgical smoke indicated by OR staffs(N=894).**

	n	%
• Asthma	321	35.90
• Anxiety	147	16.44
• Bone marrow damage	80	8.94
• Cancer	48	5.36
• Cardiovascular dysfunction	27	3.02
• Colic	198	22.14
• Dermatitis	111	12.41
• Emphysema	339	37.91
• Eye irritation	367	41.05
• Headache	528	59.06
• Hepatitis	31	3.46
• Human Immunodeficiency Virus (HIV)	28	3.13
• Human Papilloma virus (HPV)	91	10.17
• Hypoxia	223	24.94
• Lacrimation	280	31.31
• Leukemic	116	12.97
• Light-headedness	205	22.93
• Nasopharyngeal lesions	72	8.05
• Nausea	352	39.37
• Respiratory irritation	323	36.12
• Sneezing	252	28.18
• Throat irritation	271	30.31
• Unconsciousness	359	40.15
• Vomiting	321	35.90
• Weakness	184	20.58

The survey determined the following as the top health issues experienced by OR healthworkers: Headache (59.06%), eye irritation (41.05%), loss of Consciousness (40.15%), Emphysema (37.91%), vomiting (35.90%), and Throat irritation (30.31%). (Table 2)

**Table3: Preventive measures and Awareness about surgical smoke (N= 894)**

	Yes (%)	No (%)	P value
Do you had any training on surgical smoke protection?	17.01	82.99	0.51
Does the hospital have a waste gas protocol?	35.02	64.98	0.68
Are you aware of keeping the electronic gadgets outside the OT* room?	25.06	74.94	0.03
Are you aware of setting up the surgical aids for the procedure in the OT room?	15.55	84.45	0.04
Are you aware that patient can be entered to the OT only after all the preparations have done?	18.57	81.43	0.01
Are you aware of using disposable items like pen etc inside the OT room?	23.05	76.95	0.70
Do you think an experienced and qualified surgeon minimizes the operating time and therefore the SS** exposure	84.89	15.11	0.04

Do you adhere to the correct OT exit pattern? For example, the surgical team comes first, then the patient after extubation, the anaesthetic team, and finally the cleaning and sterilisation crew.	86.12	13.88	0.81
Wearing personal protection equipment (PPE) should take place in the OT room, and donning should take place in the washroom.	87.91	12.09	0.03
Barrier enclosures made of plastic or acrylic should be employed during intubation or extubation.	85.23	14.77	0.53
Use a high-quality N95Mask	83.33	16.67	0.06
Are you aware that a pre-oxygenation with 100% oxygen should last at least 5 to 10 minutes?	87.91	12.09	0.31
Use of a smoke evacuation system	87.13	12.87	0.17
Following anaesthetic induction, laminar airflow or an air conditioner should be turned on.	86.35	13.65	0.02
The air conditioner or laminar airflow should be turned off 20 minutes before the extubation.	86.68	13.32	0.03

\*OT- Operation Theatre, \*\*SS- Surgical Smoke

It was discovered that 82.99% of the study participants had not received any surgical smoke training, and 64.98% had claimed that the hospital had no waste gas protocol. Majority(74.94%) of them were not aware of keeping the electronic gadgets outside the OT room and patient entry to the OT to be restricted only after all the necessary preparations. Most of them suggested that an experienced and qualified surgeon minimizes the operating time and therefore the SS exposure. A good percentage follow a proper OT exit and donning and doffing pattern. Barrier enclosures constructed of plastic or acrylic were utilised during intubation or extubation. The OR team stated that they use a high-quality N95 and they were aware about the adequate pre-oxygenation with 100% Oxygen. Majority of them were aware about the use of Laminar airflow or air conditioner in OR.

## DISCUSSION

The pandemic provides a chance to think critically and practise evidence-based medicine rather than being driven by fear and emotion in the hunt for solutions. The best method of eliminating smoke is containment, which is best accomplished through minimally invasive surgical procedures. There is currently no proof that viruses can be transmitted through open surgical procedures, although this does not imply that they cannot. And as we are all well aware, prevention and protection are always preferable to treatment<sup>7</sup>. Surgery smoke produced by energy devices may have negative impacts on those present in the surgery room (OR). In spite of the worries that surgical smoke may cause, it's possible that no rules or regulations are in place that require preventive measures or even strict hard standards to be followed<sup>8</sup>.

The majority of study participants (82.99 and 64.98%) reported not having undergone any surgical smoke training and that their institution lacked a waste gas protocol which is alarming when compared to the results obtained by Steege AL (49%)<sup>9</sup> and similar to the findings by Arli SK<sup>10</sup>(83.9%). The signs and hazards of surgical smoke represented by OR persons were headache (59.06%), eye irritation (41.05%), loss

of Consciousness (40.15%), Emphysema (37.91%), vomiting (35.90%), and Throat irritation (30.31%) whereas Acute and chronic inflammatory respiratory changes (57.3%), headache (51.2%), nausea or vomiting (39.1%) and hypoxia or dizziness (34.1%) as reported by Giersbergen MYV<sup>11</sup>. In the analysis of Usta E<sup>12</sup>. It was found that headache (61.9%), burning in the eye (54.3%), cough (41%), and nausea(39%) were among the most frequent symptoms. In the investigation, an estimation was made that 25% of the participants developed chronic diseases after they started working in the operating room which is similar to the findings by Cavdar I.<sup>13</sup> Those who work in environments where surgical smoke is present are at risk for health problems, but the effects take time to manifest because of the low exposure level<sup>14</sup>. The majority of participants (83.33%) agreed or strongly agreed that N95 masks should be worn during surgery, showing that people would opt to take self-protective measures in some circumstances, which is slightly higher than the results found by Yu C-L(70.3%).<sup>15</sup> Use of smoke evacuation system was known to most of the participants which is in contrast with the findings by Michaelis M<sup>16</sup> wherein fewer than half of them were aware that a smoke evacuation mechanism was available.

## LIMITATIONS OF THE STUDY

The perceptions of nurses were included in the surveys to a greater extent than those of surgeons. As it is exceedingly difficult to enforce policies that are not explicit, it is not unexpected to see staff members interpreting risk on their own. The study doesn't go into more depth on the best practises for preventing surgical smoke exposure dependent on the procedure or amount of time exposed.

## CONCLUSION AND RECOMMENDATIONS

According to the study, the majority of medical workers were not trained on surgical smoke and did not employ a reliable preventive strategy. To protect against the harmful effects of surgical smoke, it is crucial to be aware of practical solutions and to spread

awareness of the issue. In this regard, it can be advised to periodically train the members of the surgical room team on how to avoid surgical smoke both during and after their time in the OT.

### SUMMARY

While performing electrosurgery, smoke evacuation systems or suction equipment should be employed, and they should be put no farther than 2 inches from the source of the smoke. Nonetheless, electrosurgery ought to be avoided wherever possible in order to protect personnel. The operating room crew is not adequately protected from the harmful effects of surgical smoke, which contains microorganisms, chemicals, and particles. N95 respirators are the preferred personal protection equipment for operating room employees who are exposed to dangerous substances during electrosurgery. The electrosurgical smoke cannot be effectively filtered with standard surgical masks due to the presence of potentially harmful chemicals.

### CONCLUSION

According to the study's practical implications, there needs to be more of a push for the proper utilization of smoke evacuation tools, such as local exhaust ventilation systems, and safety equipment, such as N95 surgical masks. Furthermore, studies evaluating the efficacy of these preventative measures must be evidence-based. There isn't enough data on laparoscopic versus open surgery to support the exclusion of laparoscopic surgery based only on SS-related risks.

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