Original Article

Surgical Smoke, Me and My Circle

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Abstract

Background: Surgical smoke can cause some problems such as headache, nausea, irritations to the eyes and respiratory tract on nurses working in the operating room.
Aims: The aim of this study is to determine the status of the exposure to the surgical smoke, the negative effects of it and the responses taken from family-members.
Methodology: This study was carried out between April 1st-May 20th 2013 on 54 nurses working in operating room units at two big university hospitals.
Results: There was any smoke evacuation device in both hospital operating rooms and aspiration catheters were used instead of them. The most negative effect was throat irritation and there was a significant difference between being scrub and having this effect ($p<0.05$). Nurses had these effects 50% after electro-surgeries and 62.7% of their family-members gave any feedback about surgical smoke when they return home.
Conclusions: The results of this study demonstrated that aspiration catheters used as an alternative smoke evacuating method are not effective and complete evacuation of surgical smoke is necessary.

Keywords: Family; Nurses; Operating rooms; Smoke; Surgery

Background

Incision and dissection with electrosurgery, laser ablation, and ultrasonic scalpel dissection are widely used in surgical technique. These techniques intentionally destroy human tissue and create a gaseous called surgical smoke (Bigony, 2007). This smoke is composed of chemicals, blood and tissue particles, viruses, bacteria and it can be seen, also smelled (González-Bayón, González-Moreno and Ortega-Peréz 2006). Electrocautery creates particles with the smallest size, laser tissue ablation generates larger particles and the largest particles are generated from the ultrasonic (harmonic) scalpel. The smaller particles can travel far away and they are more chemically based. As the particulate size increases, it acts as a vector for pathogen transmission and travels up to 1 meter from the operative field (Ott, Moss and Martinez, 1998).

The risks of smoke exposure generated by these electrosurgery devices have been investigated since the 1980s (Tomita, Mihashi, Nagata et al, 1981). So what are the effects of surgical smoke? It is known that smoke may be responsible for signs of acute problems, such as headache, nausea, muscle weakness, irritations to the eyes and respiratory tract. It can also cause burning and watery eyes, and contamination by hazardous microbes (Ball, 1995). A questionnaire-based survey was carried out by the NIOSH (National Institute for Occupational

Safety and Health) on a clinic in Dunedin (Florida) and in total, 28 people (58.3%) indicated discomfort due to the smell of the smoke (Association of Surgical Technologist, 2013). In addition, people spending 50% or more of their time close to the operating theatre indicated more symptoms than others (King and McCullough, 2006). Gatti and colleagues confirmed that smoke was mutagenic and in Wenig and colleagues' study, it was found that smoke caused changes in lung parenchyma of rats (Gatti, Bryant, Noone et al, 1992; Wenig, Stenson, Wenig et al, 1993).

Because of these unwanted hazards and potential complications, reducing the exposure of operating room (OR) staff is necessary, but making it by using surgical mask is not effective in filtering smoke particles, only effective in reducing the amount of particulate matter inhaled (O'grady and Easty, 1996). Complete evacuation of surgical smoke is the only solution to manage and control this problem. Association of Perioperative Registered Nurses (AORN) recommends that smoke evacuation systems be used whenever surgical smoke or plume is generated (AORN, 2012). But smoke evacuation still has not become standard in many settings. Commercial smoke evacuation systems installed in ORs are available, but these are relatively expensive (Ball 2001; Karoo, Whitaker, Offer et al, 2004). Because of the lack of appropriate smoke evacuation systems, surgical smoke is still an ongoing problem.

Objective

The aim of this study is to determine the status of the exposure to the surgical smoke, the negative effects of it and the responses taken from family-members.

Materials and Methods

Study setting, design and participants

This descriptive study was carried out between April 1, 2013–May 20, 2013 on 54 volunteer nurses working in OR units at Trakya University Medical Faculty and Istanbul University Çapa Medical Faculty.

Ethical considerations

Permission to conduct the study was obtained from the Director of Nursing Services and Clinical Director. Information about the study was given to all nurses and permission was obtained from the voluntary participants.

Data collection and instruments

Individual Definition Form

In the data collecting form, there were questions about demographics, the operations nurses include as scrub or circulating and operation time, usage of smoke evacuation system, status of having shower and the feed-back they take from their family members. Demographic information was collected for descriptive purposes. Yes/No questions were asked about the participant's knowledge and opinion of surgical smoke. Multiple-choice questions were focused on clinical practice experiences with smoke.

Data analysis

All data were analyzed using SPSS with descriptive statistics and Chi-Square test. The results were evaluated with $p<0.05$ significance level and 95% reliability interval.

Results

Demographic results

The mean age of the nurses was 32.83±6.41 and the average working period of time was 90.98±75.47 months. Nurses were working meanly 5.85±4.13 hours as scrub and 4.37±4.49 hours as circulating in a day. Thirty-six of these nurses (66.7%) were married and 77.8% of them were living at least two people at home. Forty-eight of the nurses were woman, and 3.7% (n=2) of the nurses were graduated from high school, 85.2% (n=46) from Bachelor of Science in Nursing and 11.1% (n=6) were from master's degree.

The Knowledge of Surgical Smoke and Evacuation System

Ninety two point six percent (n=50) of all the nurses reported that they know the meaning of surgical smoke; while 55.6% (n=30) were aware of the negative effects of it. Only 11 (20.4%) of them had taken an education about surgical smoke and 5 of them had taken the knowledge from a conference. There was any smoke evacuation devices in both hospital ORs and aspiration catheters were used instead of them. Sixty eight point five percent of nurses were aware of that aspiration catheters were alternatively used and they had any smoke evacuation system in their ORs (Table 1).

Table 1: The Knowledge Status of Surgical Smoke and Evaluation System

Knowledge Status	n	%
Knowing the Meaning of Surgical Smoke		
Yes	50	92.6
No	3	5.6
Not Sure	1	1.9
Knowing the Negative Effects		
Yes	30	55.6
No	20	37.0
Not Sure	4	7.4
Taking Education about Surgical Smoke		
Yes	11	20.4
No	43	79.6
Education Type about Surgical Smoke		
Congress	5	45.5
During School Education	1	9.1
Hospital Education	4	36.4
Individual Research	1	9.1
Knowing the Absence of Smoke Evacuation Devices		
Yes		
No	37	68.5
Not Sure	11	20.4
	6	11.1

Table 2: The Difference between Throat Irritation and Being Scrub

	Surgery Time (mean-hour)	p
Throat Irritation		
.Yes	30.73	0.037*
No	22.13	

* Statistical difference at $p \leq 0.05$

Table 3: Incidence of Family Feedback and Status of Leaving Surgery Because of Negative Effects

	n	%
Taking Family Feedback		
Always	1	2
Sometimes	18	35.3
Never	32	62.7
Leaving Surgery Because of Negative Effects		
Always	1	1.9
Sometimes	9	16.7
Never	44	81.5

Table 4: Nurses' Thoughts about Relationship between the Negative Effects, Surgery Types and Times

	n	%	\
Kind of Devices			
Electro-Surgical	27	50	
Laser	5	9.3	
All	22	40.7	
Releated to Surgery Time			
Yes	27	50	
No	23	42.6	
Not Sure	4	7.4	
Releated to Surgery Type			
Yes	30	55.6	
No	13	24.1	
Not Sure	11	20.4	
Type of Surgery			
Obstetric and Gynecologic	33	61.1	
General	31	57.4	
Orthopedic	22	40.7	
Urology	22	40.7	
Neurology	16	29.6	
Cardiovascular	16	29.6	
Plastic	10	18.5	

Effects of Surgical Smoke on Nurses

Headache was the most common negative effect with 59.3% (n=32). The other negative effects of surgical smoke on nurses were throat irritation with 56.6% (n=30), nausea with 40.7% (n=22), watery eyes with 38.9% (n=21), weakness with 24.1% (n=13) and vertigo with 9.3% (n=5). The most negative effect was throat irritation and there was a significant difference between being scrub and having this effect ($p<0.05$) (Table 2). Sixty two point seven percent of the nurses' family-members who live at least two people at home gave any feedback about surgical smoke when they return home. The others said "you smell bad/work". Instead of these negative effects, 81.5% (n=44) never left the operation (Table 3).

Negative Effects According to Surgery Types and Times

From the nurses who exposure to surgical smoke; 50% (n=27) of them stated that they had exposure the smoke mostly when they use electro-surgical devices. Fifty percent (n=27) of the nurses thought that the effects were related to the surgery time and 55.6% (n=30) of the nurses thought that they were related to the type of the surgery. Sixty one point one percent (n=33) of nurses stated that they were mostly effected from the smoke during obstetric and gynecologic surgeries. The other types of surgeries that nurses exposure the negative effects of surgical smoke were general surgery with 57.4% (n=31), orthopedic surgery and urology with 40.7% (n=22), neurology and cardiovascular with 29.6% (n=16) and plastic with 18.5% (n=10) (Table 4).

Suggestions about Protection from Surgical Smoke

Although only 25 of these nurses gave suggestion about the surgical smoke problem; 64% (n=16) of them wanted to have smoke evacuator devices, 20% (n=5) of them wanted to be educated about this subject and 16% (n=4) of them wanted to have a better air conditions in their ORs.

Discussion

The Knowledge of Surgical Smoke and Evacuation System

There is evidence in the literature showing that OR staff exposed to surgical smoke (Bigony, 2007; Beswick and Evans, 2012). Similar to our study, Marzouk found that 96.6% of the OR personnel had knowledge about hazards in OR, which also included surgical smoke (Marzouk, 1999). In this study, 55.6% of the nurses were

aware of the surgical smoke effects although Spearman et al. (2007) reported that in their study, 91% of the operating theatre nurses felt these effects (Spearman, Tsavellas and Nichols, 2007). While there are guidelines and courses about surgical smoke and preventive measures (Ball 2001; AfPP, 2009; Ball, 2010; Eickmann, Falcy, Fokuhl et al, 2011; AORN, 2012), only 20.4% of OR nurses had taken an education about surgical smoke. This result shows that nurses need more information about hazards and precautions of surgical smoke.

In limiting exposure to surgical smoke and also decreasing hazards of it, smoke evacuation devices can be used effectively however, these devices have not been used routinely and consistently in many ORs (Bigony, 2007; Ball, 2002). In accordance with the literature, both two hospitals in this study didn't use smoke evacuation devices. OR nurses working in these hospitals knew this issue but they relied that aspiration catheters may be used as an alternative to the smoke evacuation system. Spearman et al. (2007) stated that 18% of OR nurses felt that precautions taken against surgical smoke were adequate and 64% of them felt that precautions were inadequate and 18% of them were not sure of the existing situation (Spearman, Tsavellas and Nichols, 2007). Considering hazards of surgical smoke, we also thought that precautions against surgical smoke are inadequate, due to the fact that the evacuation of smoke has not been accepted widely (Ball, 2002).

Effects of Surgical Smoke on Nurses

There are many effects of surgical smoke related to hazards of it such as coughing, headache, tearing, nausea, vomiting and respiratory ill health symptoms, which has been experienced by OR staff (Alp, Bijl, Bleichrodt et al, 2006; Spearman, Tsavellas and Nichols, 2007; Beswick and Evans, 2012). In this study, most of the nurses were experiencing headache and throat irritation while 31.3% of nurses and 15.6% of surgeons participated in Marzouk's study complained respiratory problems (Marzouk, 1999). Also in the literature, it is specified that nurses exposed to surgical smoke had reported eye, nose and throat irritation, headaches, nausea, dizziness, excessive coughing, fatigue, skin irritation, increased allergies and other disorders mainly affecting the airways (Ball, 2009; Rodriguez, Albasini, Aledo et al, 2009). It is observed that in Marzouk's study these adverse effects of surgical smoke were experienced by the surgeons working with electrocautery, lazer etc. closely (Marzouk, 1999). Also in our study, results showed that there was a significant difference between being scrub and throat irritation ($p=0.037$). In the literature and this study, it is reported that irritating odor was complained by OR personnel and their relatives. Considering these adverse effects, requirement of smoke evacuation systems in ORs is coming out.

Negative Effects According to Surgery Types and Times

Surgical smoke results from the interaction of tissue and mechanical tools or heat-producing equipment (Yeh, 1997; Ball, 2001; Barrett and Garber, 2004; Bigony, 2007). In accordance with the literature, it was found that in this study, nurses exposed to the smoke in operations while using electro-surgical devices. It has been shown previously that 1 g of tissue would create a smoke plume with a mutagenic effect equivalent to smoking 3-6 unfiltered cigarettes (Ball, 2001; Shah, 2012). As in our study, it is expected that as duration of exposure to the surgical smoke gets longer, effects of the smokes will increase.

Suggestions about Protection from Surgical Smoke

There are many adverse effects of the surgical smoke associated with odor, size of the particulate matter and viability of the particulate matter (Ball, 2001). So, protection from inhalation of surgical smoke is a need for OR staff. Despite the evidence and recommendations of a variety of organizations, there are no uniform requirements mandating surgical smoke evacuation (Ulmer, 2008). Spearmen et al. (2007) reported that in their study, only 3 of 98 surgeons had used dedicated smoke extractors, despite the fact the majority (72%) felt that currently, inadequate precautions had been taken to protect staff and patients from surgical smoke (Spearman, Tsavellas and Nichols, 2007). In the literature, it was stated that 42% of the health care workers had received training that addresses the hazards of surgical smoke in the past 12 months (Association of Surgical Technologist, 2013). Also, in our study this 20% of nurses wanted to be educated about hazards and precautions of surgical smoke. We found that 64% of the nurses wanted to work with smoke evacuator devices and 16% of them wanted better air conditions in the OR. Also, Spearman

et al. (2007) reported that who participated in their study had felt precautions were inadequate and 18% had been unsure of the precautions of surgical smoke in their OR (Spearman, Tsavellas and Nichols, 2007). In another literature, 27% of health care workers had reported that their employers didn't have standard procedures about potential hazards of surgical smoke and 30% of them had been unsure about that.

Conclusion

All these results show that, although surgical smoke has many adverse effects on health, OR nurses haven't got sufficient knowledge about hazards and precautions of surgical smoke and unfortunately, employers are not taking necessary measures for OR staff. Also in this study, it is demonstrated that aspiration catheters are used as an alternative smoke evacuating method are not effective and complete evacuation of surgical smoke is necessary because of these unwanted hazards and potential complications.

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