

COMPLIANCE WITH SURGICAL SMOKE EVACUATION GUIDELINES: IMPLICATIONS FOR PRACTICE

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INTRODUCTION:

Surgical smoke (ie, plume) is produced when tissue is cut or coagulated with lasers or electrosurgery devices. Research has documented that surgical smoke creates a serious workplace hazard for more than 500,000 health care workers.¹ Toxic gases from surgical smoke create an offensive odor, small particulate matter causes respiratory complications, and pathogens may be transmitted in the surgical smoke to the surgical team.^{2,3} Surgical smoke can be effectively removed when appropriate smoke evacuation methods are used,⁴ but previous research has found that perioperative nurses do not consistently comply with smoke evacuation recommendations.⁵ Nurses consistently evacuate laser plume but not electrosurgical unit plume.^{5,6} This inconsistency of practice became the foundation for my doctoral research in 2009. I wanted to determine what factors affected perioperative nurses' compliance with smoke evacuation recommendations. I focused my study on compliance with the evacuation of electrosurgical unit smoke. I used Rogers' Diffusion of Innovations theory as the model for my research because it describes key indicators for the adoption of an innovation.⁷

Innovativeness is "the degree to which an individual...is relatively earlier in adopting new ideas than the other members of a system," according to

Rogers.⁷(p22) As described in different research studies, acceptance of new technology, innovative practices, or practice guidelines can be affected by a combination of three constructs or independent variables, including:

- individual innovativeness (ie, inherent characteristics that contribute to an individual's adoption of an innovation);
- perceptions of the innovation attributes (ie, characteristics of the innovation that influence the adoption rate); and
- organizational innovativeness (ie, organizational forces affecting adoption of an innovation).⁸⁻¹⁰

I used Rogers' model to explore perioperative nurses' individual innovativeness characteristics, including:

- age,
- education level,
- years of experience,
- amount of knowledge and training on smoke hazards and evacuation, and
- the presence of respiratory problems;

nurses' perceptions of the attributes of the smoke evacuation, including:

- relative advantage of using smoke evacuation devices versus not evacuating smoke,

ABSTRACT:

Surgical smoke presents a serious health hazard, but perioperative nurses' compliance with smoke evacuation recommendations is not consistent. I investigated key indicators for compliance with electrosurgical smoke evacuation recommendations based on nurses' individual innovativeness characteristics, perceptions of the attributes of smoke evacuation recommendations, and organizational innovativeness characteristics. The study findings provide implications for improving nurses' compliance with smoke evacuation recommendations. Individual innovativeness characteristics, including nurses' knowledge and training, were most strongly linked to smoke evacuation compliance. The key indicators that promote surgical smoke evacuation can provide direction to guide the content of education programs and help identify the personnel and settings that are most in need of this information. Barriers to compliance included lack of equipment, physician resistance, noise, and staff member complacency. Vendor demonstrations on the ease of smoke evacuation device use can show nurses that smoke evacuation is compatible with nursing practice. Facility leaders should provide smoke evacuation policies that are easy to understand and should enforce these policies.

Key words: surgical smoke, plume, smoke evacuation, inhalation risks, smoke evacuation compliance.

RÉSUMÉ EN FRANÇAIS

LE RESPECT DES LIGNES DIRECTRICES CONCERNANT L'ÉVACUATION DE LA FUMÉE CHIRURGICALE : LES IMPLICATIONS DANS LA PRATIQUE

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La fumée chirurgicale présente un risque grave pour la santé, pourtant les infirmières et des infirmiers en soins périopératoires ne respectent pas de façon cohérente les recommandations pour l'évacuation de la fumée. J'ai analysé les indicateurs clés du respect des recommandations quant à l'évacuation de la fumée électrochirurgicale en me basant sur les caractéristiques novatrices de chaque infirmière ou infirmier, sur leurs perceptions concernant les attributs des recommandations quant à l'évacuation de la fumée et sur les caractéristiques organisationnelles novatrices. Les conclusions de l'étude fournissent des mesures afin d'améliorer le respect des infirmières et des infirmiers à l'égard des recommandations concernant l'évacuation de la fumée. Les caractéristiques novatrices des personnes, y compris les connaissances et la formation des infirmières et des infirmiers, étaient l'élément le plus fortement lié au respect des

recommandations pour l'évacuation de la fumée. Les indicateurs clés faisant la promotion de l'évacuation de la fumée chirurgicale peuvent aider à déterminer le contenu des programmes éducatifs et aider à identifier le personnel et les contextes qui bénéficieraient le plus de cette information. Parmi les obstacles au respect des recommandations, notons le manque d'équipement, la résistance des médecins, le bruit et le relâchement de la vigilance des membres du personnel. Les fournisseurs faisant la démonstration de la facilité d'utilisation des dispositifs d'évacuation de la fumée peuvent donner la preuve aux infirmières et aux infirmiers que l'évacuation de la fumée est compatible avec la pratique des soins infirmiers.

Les dirigeants des établissements devraient élaborer des politiques concernant l'évacuation de la fumée qui sont faciles à comprendre et devraient les faire respecter. 🍁



Courtesy: AMT Electrosurgery

La fumée chirurgicale

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Les normes de l'AIISOC relatives à cet article figurent dans la publication Normes, lignes directrices et énoncés de positions pour la pratique de soins infirmiers périopératoires autorisés (9e édition) de l'Association des infirmiers et infirmières de salle d'opération du Canada (AIISOC) de juin 2009, section 4, p.334, Normes 1.5.

- compatibility with existing practices,
- complexity of the smoke evacuation recommendations,
- ability to use smoke evacuation devices on a trial basis,
- ability to observe the effectiveness of smoke evacuation, and
- the presence of practice barriers that may limit the use of smoke evacuation methods; and

the innovativeness characteristics of an organization, including:

- locale, type, and size of facility,
- facility complexity and formalization,
- interconnectedness,
- leadership support, and
- organizational barriers that may limit the use of smoke evacuation methods.

I compared these independent variables with the dependent variable of the different levels of compliance with smoke evacuation practices to determine significance.

DESCRIPTION OF THE STUDY

I conducted a descriptive explanatory/exploratory study using a validated, pilot-tested survey that consisted of both expert-generated questions and adaptations of previously proven measures. I chose AORN staff nurse members with e-mail addresses (N = 20,272) as the population. I invited a random sample consisting of 4,000 nurses to respond to a web-based survey during a two-month period. A total of 777 nurses completed the survey, representing a 19.4% response rate.

I used the Statistical Package for the Social Sciences version 14.0¹¹ to analyze the data, using frequency/descriptive statistical techniques, regression analyses, and bivariate analyses to examine the relationship between the key indicators and compliance with smoke evacuation recommendations. I identified significant key indicators that predict compliance with smoke evacuation recommendations. The following predictors were found to have a direct influence on promoting

compliance with surgical smoke evacuation recommendations:

- increased knowledge and training of the individual nurse;
- positive perceptions by the perioperative nurse on the attributes of smoke evacuation recommendations regarding relative advantage, compatibility, and observability;
- easy-to-understand and easy-to-implement smoke evacuation recommendations;
- larger facility size;
- larger number of specialties offered;
- greater interconnectedness; and
- strong leadership support.

I also found that:

- urban facilities were more compliant with smoke evacuation recommendations than rural facilities.
- freestanding surgery centers were more compliant with smoke evacuation recommendations than inpatient hospital surgery departments.
- academic settings were more compliant with smoke evacuation recommendations than military or government hospitals.

The presence of respiratory symptoms was weakly significant in encouraging compliance with smoke evacuation recommendations. For example, if a nurse had allergies, he or she was more apt to comply with smoke evacuation recommendations.

IMPLICATIONS FOR PRACTICE

Of the three constructs I explored in my study, individual innovativeness characteristics were most strongly linked to compliance with smoke evacuation recommendations. The individual nurse, therefore, should remain the focal point of educational programs to change behaviors and practices in the OR. Even though some organizational innovativeness characteristics are still important, they are not as critical as the individual innovativeness characteristics.

The greatest barriers to implementing smoke evacuation practices, as perceived by the nurse participants, were smoke evacuation equipment or supplies not being available for use, physicians refusing to allow smoke evacuation devices to be used, the increased noise that some smoke evacuators produce, and complacency of surgical staff members who do not want to bother with smoke evacuation. The significant predictors of smoke evacuation compliance are discussed in the following sections, as are the implications for practice in the surgical environment.

Increased Knowledge and Training of the Individual Nurse

From my study results, I noted that when nurses receive education and training on surgical smoke hazards and evacuation practices, compliance with smoke evacuation recommendations increases. Through continuing education and training, nurses are able to provide a safe surgical environment, which is a top priority for perioperative nurses. The significant key indicators identified in this study can become part of continuing education and orientation programs. Education programs can be developed that increase the nurses' knowledge and understanding of surgical smoke hazards, effective smoke evacuation methods, compliance strategies, and other key activities to ensure a safe and healthy surgical environment that is free from surgical smoke. Education courses should promote evidence-based practices by providing the results of research studies.

Even though the list of key indicators that promote compliance in my study are only a small portion of a comprehensive education package, they provide direction to guide the content development on surgical smoke hazards and will identify the target audiences that most critically needed this information. For example, because it was indicated that hospital surgery departments have lower compliance than freestanding surgery centers in relation to specific procedures, a smoke

hazards program geared toward hospitals could include a presentation on the negative consequences of breathing surgical smoke, assistance with creating an easy-to-follow smoke evacuation policy, and discussion of the importance of increased interconnectedness and leadership support in a facility for successful compliance with smoke evacuation recommendations.

Increasing everyone's awareness about smoke evacuation is crucial. One-day roundtable discussions can be conducted for diverse audiences such as nurse leaders, surgeon leaders, safety and risk managers, and companies selling smoke evacuation devices. An example of this type of meeting was held in the mid-1990s at AORN Headquarters and was very successful in introducing the initial campaign to promote smoke evacuation. Since that meeting, more information from research studies has become available that should be communicated so that the entire surgical team, other health care professionals, and industry colleagues understand the predictors and requirements for effective smoke evacuation practices.

AORN continues to promote the evaluation of surgical smoke through educational offerings and the publication of position statements and tool kits. The "AORN position statement on surgical smoke and bio-aerosols"¹² was approved by the AORN House of Delegates in 2008. This statement emphasizes the hazards of surgical smoke and AORN's position that surgical smoke can and should be controlled.

The AORN Surgical Smoke Evacuation Tool Kit was introduced at the 2009 AORN Congress to help educate AORN members on the hazards of surgical smoke so that they can successfully comply with smoke evacuation guidelines. As a benefit of AORN membership, the tool kit can be Physicians need to understand that even though they are only present in the OR on specific days, perioperative nurses are exposed to surgical smoke on a daily basis. This is one reason some

perioperative nurses have become passionate about controlling exposure to this hazard.

downloaded for free at <http://www.aorn.org/PracticeResources/Toolkits/SurgicalSmokeEvacuationToolKit/>. This tool kit provides:

- a PowerPoint® presentation that can be used to offer continuing education credit;
- a bibliography of references on surgical smoke;
- examples of "no smoking" (ie, no smoke plume) reminder signs to display throughout the OR;
- a sample policy on smoke evacuation;
- a competency skills checklist for smoke evacuation practices; and
- links to vendors that sell smoke evacuation equipment, devices, and supplies.

Lectures on surgical smoke hazards at the 2008, 2009, and 2010 AORN Congresses also highlighted key areas that nurses must fully understand to promote smoke evacuation compliance (eg, recommended practices, research findings). AORN continues to recommend the evacuation of all surgical smoke to help ensure a safe workplace for all surgical team members and patients.

Education also must extend to the physician community. Information about surgical smoke hazards and reasons for compliance with smoke evacuation recommendations can become a topic of discussion between nurses and physicians. These conversations can be used to garner physician support for nurses who strive to comply with smoke evacuation recommendations. Physicians need to understand that even though they are only present in the OR on specific days, perioperative nurses are exposed to surgical smoke on a daily basis. This is one reason some perioperative nurses have become passionate about controlling exposure to this hazard.

Physicians must be educated on the documented hazards of smoke

inhalation and be provided with research references to validate these findings. Many physicians need to see evidence before they are willing to change surgical practices. It is important to convey to surgeons that nurses in my study indicated that physicians represent a barrier to the implementation of effective smoke evacuation practices. Educational activities must challenge the negative attitudes or behaviors that some physicians demonstrate regarding surgical smoke evacuation. Many physicians need to be convinced that their procedure cards must include smoke evacuation devices for procedures that create surgical smoke. Nursing leaders usually have positive relationships with physicians and can provide compelling evidence through research studies that surgical smoke is hazardous and must be evacuated. Physicians need to be reminded that this is a workplace safety issue more than a patient safety concern.

Positive Perceptions About the Attributes of Smoke Evacuation Recommendations

In my study, nurses were asked to answer questions about their perceptions of the attributes of surgical smoke recommendations. Results showed that if a nurse had positive perceptions about these attributes, then he or she was more apt to comply with smoke evacuation recommendations. These attributes, as described in the following text, offer more understanding about why nurses evacuate surgical smoke; thus, these indicators can be incorporated into education and training programs.

- When nurses can observe the relative advantage of using smoke evacuation methods, they are more apt to comply with recommendations.
- Demonstrations of the ease of smoke evacuation device use can show nurses that smoke evacuation practices are compatible with the duties of a perioperative nurse and that smoke evacuation fits easily into the workflow of a nurse.

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SURGICAL SMOKE (cont.)

- If smoke evacuator use is demonstrated, nurses can observe how smoke evacuation devices effectively remove the particulate matter and toxic gases from the air.

Testimonials provided by perioperative nurses with respiratory conditions associated with smoke exposure also can be used to powerfully illustrate the negative consequences of smoke inhalation. This, in turn, can help to convince nurses of the need to evacuate all surgical smoke.

Ease of Understanding and Implementing Smoke Evacuation Recommendations

If smoke evacuation policies are easy to understand and implement, then nurses are more apt to comply with them. Policies involving smoke evacuation must be reviewed annually and updated to ensure compliance is possible. AORN recommended practices for

electrosurgery,¹³ laser safety,¹⁴ a safe environment of care,¹⁵ and minimally invasive surgery¹⁶ describe the appropriate use of smoke evacuation devices and can be used as models for the creation of smoke evacuation policies. Smoke evacuation policies must be communicated to the surgical staff members and physicians but, most importantly, the policy must be simple and easy to follow. A smoke evacuation policy should state that smoke evacuation devices or equipment must be listed on all surgeon procedure cards for procedures that produce any surgical smoke, no matter how large or small. Compliance with smoke evacuation policies should be monitored and consequences enforced if the policies are not being followed.

Organizational Characteristics

I found that organizational characteristics of facilities where perioperative nurses are more apt to

comply with smoke evacuation recommendations include larger facilities with multiple specialties, urban facilities, freestanding surgery centers, and academic settings. Therefore, these facilities can be used as models for others that continue to struggle with smoke evacuation compliance. For example, smaller facilities with fewer specialties, rural in facilities, hospital-based ORs (as compared with freestanding surgical centers), and military or government hospitals (as compared with academic settings) are less likely to evacuate plume. Educational programs in these facilities should be offered that focus on promoting smoke evacuation compliance. Educational sessions on surgical smoke can be accessed via the Internet in hospitals, especially in rural facilities that may not be able to afford the cost of sending their nurses to outside conferences.

SURGICAL SMOKE cont. on Page #35

Strong leadership support is a key indicator to compliance with smoke evacuation recommendations.

Vendors who distribute smoke evacuation equipment and supplies can easily target less-compliant settings to help encourage compliance with smoke evacuation recommendations. The identified key indicators for compliance with smoke evacuation recommendations provide valuable information for the industry representative who markets and sells smoke evacuation devices. Industry representatives can focus on providing education and copies of research studies, study guides, and presentation materials to customers who may not understand the hazards of surgical smoke and compliance issues.

The results of my study also offer valuable information to smoke evacuation companies that strive to continually advance and enhance smoke evacuation systems. As the study findings reveal, the availability of smoke evacuators and their noise level are both barriers to the implementation of smoke evacuation recommendations. Vendors of smoke evacuation devices promote their products at conferences, through advertisements in the AORN Journal and other sources, and during evaluations and trials. Equipment demonstrations help encourage the use of smoke evacuation devices as the surgical team observes the ease of use and the effectiveness of removing the odor and visible smoke produced during surgical procedures. Smoke evacuators are now designed to produce minimal amounts of noise. The surgical team can use automatic sensors or foot switches that immediately activate and deactivate the smoke evacuator when plume is created to decrease the amount of continual noise generated in the OR. The motor in the smoke evacuator must be strong enough and responsive enough to provide immediate suction power so that no particulate matter escapes capture. Manufacturers continue to encourage compliance by providing smoke evacuation technology that is easy to use and effective in plume capture.

Greater Interconnectedness

The importance of creating and fostering a solid system of interconnectedness (ie,

the degree to which there are linkages through interpersonal networks) must be promoted because nurses practicing in facilities with increased interconnectedness are more apt to comply with smoke evacuation recommendations. Administrators must realize that formal and informal interpersonal networks in a health care facility are extremely important to the success of a smoke evacuation program. Word travels fast when a strong collaborative network exists in a facility. When the workplace environment is considered unsafe, this interpersonal network can carry the message quickly to the top administrators to inform them that problems may exist. Greater attention to controlling and addressing these concerns may be fostered in a more interconnected workplace.

The basis of a strongly interconnected system is teamwork. I used survey questions in my study to ask nurses a variety of questions about collaborative activities that promote interconnectedness. Results indicated that increased interconnectedness exists when nurses and physicians plan together; openly communicate; share decision-making responsibilities; and cooperate, coordinate, and collaborate when decisions about smoke evacuation practices are being made. Nurses' reports of being satisfied with the process by which decisions are made about smoke evacuation practices are associated with greater interconnectedness in their organizations; thus, these nurses are more apt to comply with smoke evacuation recommendations. These different attributes can be considered when trying to increase compliance with smoke evacuation recommendations.

Strong Leadership Support

Strong leadership support is a key indicator to compliance with smoke evacuation recommendations. Managers must realize that the leaders in the surgical department should enthusiastically support any activities that promote compliance with smoke evacuation recommendations so that

Surgical smoke will continue to exist in surgical suites if appropriate smoke evacuation practices are not used.

staff members will be encouraged to evacuate plume. Leaders must show a keen interest in making sure the workplace environment is safe for the surgical team by making smoke evacuation devices available and by mandating their use through policy enforcement. Key activities to promote smoke evacuation can be provided by:

- conducting educational activities,
- posting “no smoking” (ie, no smoke plume) signs throughout the surgical environment,
- creating smoke evacuation policies and enforcing them,
- collaborating with physicians,
- imposing consequences for noncompliance, and
- making smoke evacuation equipment and supplies readily accessible.

Nurses can design and implement algorithms of practice that incorporate surgical smoke evacuation for all procedures that produce plume. Nurses use algorithms as a basis for the sequence of actions needed to effectively solve a problem. For example, the sequence of actions to address surgical smoke involves the nurse gaining knowledge about smoke hazards. Knowledge of these hazards helps the nurse create a policy addressing the smoke evacuation practices and appropriate equipment needed for each procedure that creates smoke plume. The nurse ensures that the proper smoke evacuation equipment and supplies are available, educates the surgical team on their use, and then monitors compliance with the written smoke evacuation policy.

Respiratory Problems

The results of my study revealed that perioperative nurses have twice the incidence of some respiratory problems compared with the general population. Nurses’ respiratory problems may be linked to the cumulative inhalation of surgical smoke contaminants. Results indicated that nurses who reported respiratory conditions were usually more alert to the need to evacuate surgical smoke and comply with smoke

evacuation recommendations. Nurses must be reminded that respiratory symptoms may be exacerbated by continual exposure to plume, so smoke must be evacuated to provide clean air in the workplace. Testimonial accounts by nurses with respiratory problems can be a very significant and powerful part of an educational program that promotes smoke evacuation. Nurses with respiratory conditions are beginning to realize that the continual inhalation of surgical smoke may be the origin of these problems and also may aggravate these conditions.

CONCLUSION

Surgical smoke will continue to exist in surgical suites if appropriate smoke evacuation practices are not used. Perioperative nurses exposed to surgical smoke will continue to be at high risk for the development of respiratory problems if this hazard is not addressed appropriately. No longer should the nurse be treated like the canary that served as the biological indicator of poor air quality in a coal mine. Mandates for smoke evacuation should be made before increased health problems appear in perioperative personnel.

The results of my study reflect key indicators associated with compliance with surgical smoke evacuation recommendations. This valuable information can be used to guide the path of educational programs, practices, and attitudes toward compliance with smoke evacuation recommendations, but there is a long way to go before surgical practices and mindsets about the need for smoke evacuation are consistent. The results of my study represent just one more piece in the puzzle of compliance with smoke evacuation recommendations; however, the identified key indicators provide a map to begin the pursuit of compliance.

In 2005, Erin Andersen posed a powerful question, “In hindsight, will health care professionals be embarrassed about their cavalier attitudes toward surgical smoke as they once were with cigarette smoke?”¹⁷(p103) The outcomes of my

study indicate that compliance with smoke evacuation recommendations is lacking and comprehensive education about surgical smoke hazards is needed. Until perioperative professionals become passionate about the evacuation of all surgical smoke, this hazard will continue to exist in the surgical environment and also in our lungs.

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ORNAC Standards pertaining to this article can be found in the Operating Room Nurses Association of Canada (ORNAC) (May 2011). Standards, Guidelines, and Position Statements for Perioperative Registered Nursing Practice (10th edition), Section 3, p. 226 Standard (s) 4.1.1.