

Alleviating the dangers of surgical smoke

Issue:

Whenever and wherever lasers, electrosurgical systems, radio frequency devices, hyfrecators, ultrasonic scalpels, power tools, and other heat destructive devices are used, everyone in the area — including the patient — may be exposed to surgical smoke. Surgical smoke is a by-product created by the thermal destruction of tissue by these devices. Areas traditionally affected include operating rooms and procedural areas, such as gynecology and dermatology, but additional areas may be affected depending on the services and type of equipment used to provide patient care.

Research studies confirm that the surgical smoke plume can contain toxic gases and vapors such as benzene, hydrogen cyanide, formaldehyde, bioaerosols, dead and live cellular material (including blood fragments), and viruses.¹ In some fields, such as orthopedics, dentistry and plastic surgery, it is also possible to generate particulates and metal fumes.²

While exposure of surgical smoke to patients is short-term and relatively low risk,³ surgeons, perioperative nurses and other OR staff are exposed to surgical smoke daily.⁴ At high concentrations, the surgical smoke causes ocular and upper respiratory tract irritation and creates visual problems for the surgeon.

The literature reveals that nanoparticles comprise 80% of surgical smoke and are the real danger of inhaled smoke.⁵ These are less than 100 nanometers in size (i.e., 0.1 micron), and when inhaled, enter a person's blood and lymphatic circulatory systems, and travel to various distant organs.⁶

One study identified the problems experienced by nurses and doctors as a result of exposure to surgical smoke, which included: headache (nurses: 48.9%, doctors: 58.3%), watering of the eyes (nurses: 40.0%, doctors: 41.7%), cough (nurses: 48.9%, doctors: 27.8%), as well as sore throat, nausea, drowsiness, dizziness, sneezing, rhinitis, and bad odors absorbed in the hair.⁷ It's been shown that surgical smoke can cause in-vitro mutations and be a contributing factor to higher rates of pregnancy complications for female surgeons.⁸ There also is evidence that surgical smoke can transmit viable bacteria and human papillomavirus (HPV).⁹

Current regulations, recommendations and standards regarding surgical smoke or lasers

In June 2018, Rhode Island became the first state to enact legislation to ensure that all hospitals and freestanding ambulatory surgery centers use a smoke evacuation system for relevant surgical procedures. Colorado followed suit in March 2019, and several states are considering similar legislation. Organizations should review their state requirements regarding surgical smoke evacuation.

The following governmental and professional organizations have recommendations or standards related to surgical smoke or the use of lasers:

- **Occupational Safety and Health Administration (OSHA):** OSHA explicitly recommends local smoke evacuation systems as they may improve the quality of the operating field. While OSHA does not have regulatory standards directly requiring evacuation of surgical smoke, its General Duty Clause states: "Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees." Not controlling smoke exposure in the surgical suite and exposing employees to hazardous surgical smoke could violate the OSHA General Duty Clause to provide a work environment free of recognized hazards.
- **National Institute of Occupational Safety and Health (NIOSH):** Part of the Centers for Disease Control and Prevention (CDC), NIOSH provides recommendations and interventions for the building of a healthy, safe and capable workforce. It's [HC 11 - Control of Smoke from Laser/Electric Surgical Procedures](#) provides recommended ventilation techniques that include a combination of general room and local exhaust ventilation (LEV). By itself, general room ventilation is insufficient to capture contaminants generated at the source. The NIOSH website also provides guidance on the control of surgical smoke, specifically ventilation and work practices, and general principles for minimizing employee exposure to airborne contaminants.



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- **American National Standards Institute (ANSI):** A private, not-for-profit organization, ANSI is dedicated to supporting the U.S. voluntary standards and conformity assessment system and strengthening its impact, both domestically and internationally. *ANSI Z136.3-2018: Safe Use of Lasers in Health Care* provides guidance to employers for establishing laser safety policies and procedures and training programs in safe laser use, and it includes engineering, procedural, and administrative controls and laser safety training. The document details information on the environment, non-beam hazards, and examinations following laser-induced injuries. Overall, the standard is intended for use by all people associated with the application, installation, operation, calibration, maintenance, and service of a health care laser system (HCLS), as well as others exposed to lasers being used as medical devices or in health care applications.
- **Association of periOperative Registered Nurses (AORN):** The evidence-based 2017 AORN Guideline for Surgical Smoke Safety documents the hazards of continuous exposure to surgical smoke and includes recommended practices for evacuation (Recommendations I-V).
- **ECRI:** A not-for-profit organization with the mission to improve the safety, quality, and cost-effectiveness of care across all settings published a health care risk, quality and safety guidance article about smoke evacuation in 2018. This membership publication outlines safety concerns surrounding surgical smoke. It also provides guidance on the development of policies and procedures for surgical smoke evacuation, selection and purchase considerations of appropriate smoke evacuation systems and personal protective equipment (PPE), and recommendations regarding staff education.¹⁰

Safety actions to consider:

The Environment of Care (EC) chapter of the Joint Commission's accreditation manuals for hospitals, critical access hospitals, ambulatory care and office-based surgeries includes a standard (EC 02.02.01 element of performance 9) that requires these organizations to minimize risks associated with selecting, handling, storing, transporting, using, and disposing of hazardous gases and vapors. The standard includes the following note: *Hazardous gases and vapors include, but are not limited to, ethylene oxide and nitrous oxide gases; vapors generated by glutaraldehyde; cauterizing equipment, such as lasers; waste anesthetic gas disposal (WAGD); and laboratory rooftop exhaust. (For full text, refer to NFPA 99-2012: 9.3.8; 9.3.9)*

Health care organizations that conduct surgery and other procedures using lasers and other devices that produce surgical smoke should take the following actions to help protect patients and especially staff from the dangers of surgical smoke.

- Implement standard procedures for the removal of surgical smoke and plume through the use of engineering controls, such as smoke evacuators and high filtration masks.^{11,12,13,14,15} Use specific insufflators for patients undergoing laparoscopic procedures that lessen the accumulation of methemoglobin buildup in the intra-abdominal cavity. (Surgical smoke is cytotoxic if absorbed into the blood and can cause elevated methemoglobin.) For example, a lapro-shield smoke evacuation device — a filter that attaches to a trocar — helps clear the field inside the abdomen.
- During laser procedures, use standard precautions, such as those promulgated by the Blood-Borne Pathogen Standard (29CFR1910.1030) and the CDC's *Core Infection Prevention and Control Practices for Safe Healthcare Delivery in All Settings*, to prevent exposure to the aerosolized blood, blood by-products and pathogens contained in surgical smoke plumes.¹⁶
- Establish and periodically review policies and procedures for surgical smoke safety and control. Make these policies and procedures available to staff in all areas where surgical smoke is generated.¹¹
- Provide surgical team members with initial and ongoing education and competency verification on surgical smoke safety, including the organization's policies and procedures.^{11,17}
- Conduct periodic training exercises to assess surgical smoke precautions and consistent evacuation for the surgical suite or procedural area.¹¹

Resources:

1. Centers for Disease Control and Prevention. [HC 11 - Control of Smoke from Laser/Electric Surgical Procedures](#).
2. American National Standards Institute (ANSI). *ANSI Z136.3-2018*. 7.4 Laser Generated Airborne Contaminants (LGAC); Plume and Airborne Contaminants (PAC).



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4. Schultz L. An analysis of surgical smoke plume components, capture & evacuation. *AORN Journal*, 2014;99(2):289-298.
5. Buzea C, et al. Nanomaterials and nanoparticles: Sources and toxicity. *Biointerphases*, 2007;2(4):MR17-MR71.
6. Nemmar A, et al. Passage of inhaled particles into the blood circulation in humans. *Circulation*, 2002;105(4):411-414.
7. Ilce A, et al. The examination of problems experienced by nurses and doctors associated with exposure to surgical smoke and the necessary precautions. *Journal of Clinical Nursing*, 2016;26:1555-1561, doi: 10.1111/jocn.13455
8. Occupational Reproductive Hazards for Female Surgeons in the Operating Room: A review, JAMA Surgery, January 2, 2020.
9. Stratton M. [Surgical smoke transmits infectious diseases: here's how to stop it](#). *Infection Control Today Online*, April 3, 2017.
10. ECRI Institute. Surgical smoke evacuation systems. *Healthcare Risk Control*, May 16, 2018.
11. Association of periOperative Registered Nurses (AORN). 2017 Guidelines for Perioperative Practice, First Published: December 2016. Denver, Colorado.
12. American National Standards Institute (ANSI). *ANSI Z136.3-2018*. 7.4.2 Control Measures. Washington, D.C.
13. American National Standards Institute (ANSI). *ANSI Z136.3-2018*. 7.4.2.1 Local Exhaust Ventilation (LEV). Washington, D.C.
14. American National Standards Institute (ANSI). *ANSI Z136.3-2018*. 7.4.2.3 Respiratory Protection. Washington, D.C.
15. The Joint Commission. *Implementing Hospital Respiratory Protection Programs: Strategies from the Field*. Oakbrook Terrace, Illinois: The Joint Commission, December 2014.
16. American National Standards Institute (ANSI). *ANSI Z136.3-2018*. 7.4.1 PAC (LGAC) Infection Control. Washington, D.C.
17. American National Standards Institute (ANSI). *ANSI Z136.3-2018*. 7.4.2.2 Policies and Procedures. Washington, D.C.

Additional resource:

Association of periOperative Registered Nurses. [AORN Go Clear Award™ program](#). This comprehensive surgical smoke-free recognition program is free to facilities that want to ensure a smoke-free environment for its surgical teams. The Go Clear Award™ program provides supportive information and tools.

Note: This is not an all-inclusive list.



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