Learn the facts about hazardous surgical smoke and promote positive outcomes in your surgical facility.

The topic of smoke evacuation during surgery continues to gain momentum as a result of strong educational efforts, growing awareness, and new regulations and standards. For three decades, studies have clearly defined the potential health hazards caused from exposure to surgical smoke. Consensus authorities urge healthcare workers to educate themselves on the dangers of surgical smoke exposure and take action to implement smoke evacuation procedures and other protective measures.

Regulations, Hazard Evaluations and Surgical Organization Position Statements

**OSHA (Occupational Safety & Health Administration)**

General Industry (29 CFR 1910), 1910 Subpart I, 1910.134 Paragraph (a)(1) states, “The primary objective is to control occupational diseases caused by breathing air contaminated with harmful substances. This is to be accomplished through accepted engineering controls, if feasible, or through the use of appropriate respirators. . . surgical masks . . . are not certified for respiratory protection of medical employees.”

General Industry (29 CFR 1910), 1910 Subpart 7, 1910.130 Paragraph (d)(3)(i) states, “The employer must supply appropriate personal protective equipment such as gloves, gowns, masks and eye protection. This standard would apply if such items would become contaminated with viable bloodborne pathogens from laser smoke or plume.”

“Each year, an estimated 500,000 workers, including surgeons, nurses, anesthesiologists, and surgical technologists, are exposed to laser or electrosurgical smoke. Surgical plumes have contents similar to other smoke plumes, including carbon monoxide, polyaromatic hydrocarbons, and a variety of trace toxic gases.”

“Compliance and consultative personnel should be aware of [this] emerging problem and advise medical personnel of the possible hazard of laser smoke during compliance inspections and consultative visits.”

**JCAHO (Joint Commission on Accreditation of Healthcare Organizations)**

The hospital minimizes risks associated with selection, handling, storage, transport, use, and disposing of hazardous gases and vapors. Note: Hazardous gases and vapors include, but are not limited to, glutaraldehyde, ethylene oxide, vapors generated while using cautering equipment and lasers, and gases such as nitrous oxide.
NIOSH/CDC (National Institute for Occupational Safety and Health/Center for Disease Control)  
NIOSH research has shown airborne contaminants generated by these [laser or electrosurgical unit] surgical devices can be effectively controlled.  
- The smoke evacuator or room suction hose nozzle inlet must be kept within 2 inches of the surgical site to effectively capture airborne contaminants generated by these surgical devices.  
- Generally speaking, the use of smoke evacuators are more effective than room suction systems to control the generated smoke from non-endoscopic laser/electric surgical procedures.

Position Statements and Standards  
AORN (Association of periOperative Registered Nurses)  
Potential health and liability risks may be reduced by the evacuation of surgical smoke... The capture device... of the smoke evacuation system should be positioned as close as possible, and no greater than 2 inches... from the source of the smoke... Surgical and high-filtration masks do not seal to the face and may allow dangerous contaminants to enter the health care worker's breathing zone.

CSA (Canadian Standards Association)  
Laser plume may contain carcinogens, mutagens, irritants, and fine dusts. Contaminants generated by lasers and electrosurgical units can be controlled by: ventilation, safe work practices, and personal protective equipment.

ISSA (International Social Security Association)  
The aim is to establish the state of current knowledge on existing hazards, and above all to indicate the preventive measures that can be implemented to protect the health of exposed personnel.

IFPN (International Federation of periOperative Nurses)  
It is important that employers and employees are aware of the problem of smoke plume and ensure that there are policies in place to reduce the exposure to smoke plume.

AfPP (The Association for Perioperative Practice)  
Standard 2.6 Lasers states: Dedicated smoke evacuation machines must be used to remove the smoke.

PROBLEM: Irritant, carcinogenic and neurotoxic compounds exist in surgical smoke  
- Researchers were able to quantify the presence of toluene, ethylbenzene and xylene present in the smoke which appeared in quantities similar to cigarette smoke.  
- When evaluating over a 44-day period, the following chemicals were found in surgical smoke: acetonitrile furfural (aldehyde), acetylene hexadecanoic acid, acroloin hydrogen cyanide, acrylonitrile indole (amine), alkyl benzene isobutene, benzaldehyde methane, benzene 3-methyl butenal (aldehyde), benzonitrile 6-methyl indole (amine), butadiene 4-methyl phenol, butane 2-methyl propanol (aldehyde), 3-butenenitrile methyl pyrazine, carbon monoxide phenol, creosol propene, 1-decene (hydrocarbon) 2-propylene nitrile, 2,3-dihydro indene pyridine, ethane pyrrole (amine), ethene styrene, ethylene toluene (hydrocarbon), ethyl benzene 1-undecene (hydrocarbon), ethynyl benzene xylene, and formaldehyde.
In one particular study, researchers identified Furfural present in the composition of surgical smoke. The solvent (a strong irritant affecting the eyes, mucous membranes, lungs and central nervous system) was found at a level of 12 times higher than the recommended occupational exposure limit.12

There is a mixture of both hazardous chemicals and potentially infectious biological substances within surgical smoke. While the presence of hazardous substances was found, there were few studies that quantified the level of exposure to OR staff.13

**PROBLEM: Electrosurgical smoke compounds pose a health risk to exposed perioperative staff and patients**

- The presence of irritant, carcinogenic and neurotoxic compounds in surgical smoke . . . may have considerable implications for the health and safety of all involved in surgical practice, as exposure to these compounds pose potential risks to health.10
- The carbon monoxide generated during electrocautery can cause headaches and nausea, and be undetected by pulse oximetry. Surgical smoke and aerosols irritate the lungs and have similar mutagenicity of cigarette smoke.14
- Potential risks of surgical smoke inhalation include: acute and chronic inflammatory changes (emphysema, asthma, chronic bronchitis), hypoxia/dizziness, eye irritation, nausea/vomiting, headache, sneezing, weakness, light-headedness, carcinoma, dermatitis, cardiovascular dysfunction, throat irritation, lacrimation, colic, anxiety, anaemia, leukaemia, nasopharyngeal lesions, human immunodeficiency virus, and hepatitis.11
- On average, in order to produce the same level of mutagenicity, 27-30 cigarettes would need to be smoked in the OR on a daily basis.11
- A laser surgeon contracted laryngeal papillomatosis after treating patients with anogenital condylomas. Research findings suggest the surgeon may have contracted the disease by inhaling the laser plume, which was likely laden with virus particles.15
- Garden et al reported that, “Papillomavirus found in laser plume resulted in disease transmission in a bovine model. Tumors grew at plume-inoculated sites for all laser parameter settings.”16
- A study in mice showed that melanoma cells were released into the plume in an aerosol form after application of electrocautery to malignant tissues. The cells were viable after release and were able to be grown in cultures.17

**PROBLEM: Current practices/protective measures do not adequately safeguard staff and patients against the dangers of exposure to surgical smoke.**

- Smoke extraction devices are available, their use is still surgeon specific.11
- Standard OR ventilation is ineffective at removing smoke directly where it is generated.11
- Carbon monoxide generated during electrocautery...is undetected by pulse oximetry.14
- Staff in the OR should take any available precaution to protect themselves from surgical smoke, including using smoke evacuators and high-filtration masks.14
- Surgeons should ventilate the abdomen periodically.14
- Add-on cannula filters should be utilized.14
- A well-functioning smoke evacuator is of greatest importance to the surgical team.15
- Ordinary masks may also be an ineffective method of preventing inhalation of HPV DNA.15
• One study found increased carboxyhemoglobin and methemoglobin levels in patients exposed to laparoscopic smoke plume.\textsuperscript{18}

• “In hindsight, will health-care professionals be embarrassed about their cavalier attitudes toward surgical smoke as they once were with cigarette smoke?”\textsuperscript{19}

References