

Patient safety

Hiding in plain sight: Surgical smoke threatens health of OR staff

Research has shown that electrosurgical smoke presents a serious health hazard for the OR team. However, many remain skeptical of its harmful effects, and compliance with smoke evacuation recommendations is not consistent.

Electrosurgical smoke results from the vaporization of tissue, fluid, and blood into a gaseous form by electrosurgical instruments. The smoke can contain live and dead cellular material including viruses and bacteria. Chemicals are produced, some of which are carcinogenic.

Environmental health research has shown that the real danger is with nanoparticles, which comprise 80% of surgical smoke, Leonard Schultz, MD, FACS, told OR Manager. These ultrafine particles are less than 100 nanometers in size. When inhaled, they can cross the alveolar membranes and enter a person's blood and lymphatic circulatory systems and travel to distant organs.

"It is this environmental health research that should make evacuation of surgical smoke a priority for surgeons and nurses," says Dr Schultz.

Dr Schultz is former clinical assistant professor of surgery, University of Minnesota Medical School, Minneapolis, and CEO and chairman of Nascent Surgical, LLC, Eden Prairie, Minnesota. Nascent Surgical manufactures the miniSQUAIR surgical smoke evacuation system.

Getting rid of the smoke

Dr Schultz first became interested in surgical smoke when he began using lasers in the mid-1980s to vaporize tumors after they had been shrunk with radiation and chemotherapy. "Until [Wyman] Stackhouse came up with his early smoke evacuator, vaporization of these tumors would fill the room with smoke, so much so that we couldn't tolerate it," he says.



Leonard Schultz,
MD, FACS

Since then, Dr Schultz says, it has been his passion to figure out how to rid the OR of surgical smoke. "In order to do my work, and have a team that would work with me, I had to figure out some way to get rid of the smoke, and that's what led me to start inventing things," he says.

"This is an emotional thing for me," says Dr Schultz. "My wife works in the OR, and I want her to be protected. I wish I could have protected myself better because over the years the smoke destroyed my sinuses."

Getting surgeon buy-in

A 2010 study by Ball that surveyed AORN members on key indicators of compliance with surgical smoke evacuation revealed that one of the reasons nurses weren't using smoke evacuators was that surgeons told them they didn't have to do it.

"Surgeons tell staff they don't have to use smoke evacuation for a number of reasons," says Dr Schultz:

- They're uneducated on the subject.
- They have never read an article on smoke evacuation in a surgical journal.
- They are leery about introducing anything that would change their operative protocol.

“We’re talking about a small change here, but anything that changes a surgeon’s protocol, like having a hose or a wand disturb their vision or attaching tubing to an electrosurgical pencil, will be met with resistance,” he says.

The surgeon’s typical comment, says Dr Shultz, is: “I’ve been operating for 30 years, and it hasn’t done me any harm.”

However, Dr Schultz points out, exposure is much less for surgeons who are in a case for 1 to 2 hours a couple of days a week. The rest of the OR team is there 8 or more hours a day, 5 or more days a week.

Nurses have become the biggest advocates for evacuating surgical smoke because they are the most exposed, and they have been educated on the harmful side effects, he says.

Dr Schultz has looked at ways to get surgeons to buy in to smoke evacuation.

“Smoke evacuation doesn’t put any dollars in their pockets, but they care about their patients’ outcomes, and that’s what we need to study,” he says.

Dr Schultz and his colleagues at Nascent Surgical recently conducted a study in which they hypothesized that smoke evacuation could play a role in capturing bacteria in the OR and, thus, could be an unrecognized form of infection control.

The experimental study was designed with an independent third-party team of bacteriology experts, using porcine tissue embedded with the bacterium *Serratia marcescens* to determine the extent of viable bacteria present in smoke.

The results showed that only blended current electrosurgery, not laser plume or coagulation electrosurgery, contained viable bacteria, and that placing a suction device near the electrosurgical site reduced the number of aerosolized viable bacteria.

They concluded that evacuating electrosurgical smoke may help reduce contamination of the surgical wound.

The next step is to have a coordinated effort to show that effective smoke evacuation decreases surgical site infections, says Dr Schultz.

Hospital policy, central vacuum systems are key

Several organizations have standards and guidelines on patient and healthcare worker exposure to hazardous materials and surgical smoke (sidebar, p 16). Unfortunately, they have no regulatory enforcement authority, and compliance is low.

In the late 1990s, a bill was introduced by Congressman Carlos Romero-Barcelo from Puerto Rico to have the Occupational Health and Safety Administration mandate surgical smoke evacuation. The bill made it to budget reconciliation, and then the smoke evacuation part was cut.

Future mandates will have to turn from federal and organizational policy to an individual hospital-wide or health system-wide policy for smoke evacuation, says Dr Schultz. Once the hospital has a policy, the surgeons have to adhere to it, he says.

This is what Canadian hospitals have done, and smoke evacuation is now used in 80% of surgical cases in that country.

The Scandinavian countries are also way ahead of the US, says Dr Schultz. Hospitals in Sweden want the smoke to be not only filtered but removed entirely from the OR with central vacuum systems for smoke evacuation.

Dr Schultz believes central smoke evacuation is the ultimate answer.

“The smoke evacuation industry has to change,” he says. “We have to get away from pencil evacuators because their smoke capture efficiency is not high enough. We have to get away from filters because they are expensive and ineffective.”

Potential liability suggests need for change

The ultra-low particulate air filters that are in evacuators add about \$25 per case, and

American National Standards Institute (ANSI)

American National Standard for Safe Use of Lasers in Health Care ANSI Z136.3 (2011)—Standard 7.4 Laser Generated Airborne Contaminants (LGAC)

The standard requires that laser plume (airborne contaminants) be controlled by the use of ventilation and respiratory protection. ANSI refers to smoke evacuators as “local exhaust ventilation” and indicates they shall be the primary method of control. The associated filters are to be considered a biohazard and properly disposed of (red bagged with the use of gloves). The standard notes that electro-surgical smoke creates the same pollutants as laser plume.

<https://www.lia.org/store/ANSI/113>

Occupational Safety and Health Administration (OSHA)

General Duty Clause: Employers must provide a safe workplace environment

OSHA has no specific standards for laser/electrosurgical plume hazards, but recognizes that surgical plumes have contents similar to other smoke plumes, including carbon monoxide, polyaromatic hydrocarbons, and trace toxic gases that can produce upper respiratory irritation and have mutagenic potential.

The OSHA General Industry (29 CFR 1910) standard’s 1910 Subpart I: 1910.134 on respiratory protection states that the primary objective is to control occupational diseases caused by breathing air contaminated with harmful substances, and this is to be accomplished through ac-

cepted engineering controls of the use of appropriate respirators.

The 1910 Subpart Z: 1910.1030 on bloodborne pathogens says the employer must supply appropriate personal protective equipment and that this standard would apply to viable bloodborne pathogens from laser smoke or plume.

<https://www.osha.gov/SLTC/laser-electrosurgeryplume/standards.html>

Association of periOperative Registered Nurses

AORN Recommended Practices (RP) for Electrosurgery

AORN recommends that potential hazards associated with surgical smoke generated in the practice setting should be identified, and safe practices established.

Recommended Practice X says to evacuate smoke with an evacuation system in open and laparoscopic procedures. The recommended practice also says used evacuator filters, tubing, and wands should be disposed of as potentially infectious waste.

<https://www.medline.com/media/mkt/pdf/research/or-safety-lean/AORN-electrosurgery-guidelines.pdf>

National Institute of Occupational Safety and Health (NIOSH)

Control of Smoke from Laser/Electric Surgical Procedures DHHS (NIOSH) Publication Number 96-128 (1996)

Smoke plume from surgical procedures using a laser or electro-surgical unit can contain toxic gases and vapors, bio-aerosols, dead and live cellu-

lar material, and viruses, and has been shown to have mutagenic potential. These airborne contaminants can be effectively controlled by techniques that include general room and local exhaust ventilation (LEV).

The two major LEV approaches used to reduce smoke levels are portable smoke evacuators and room suction systems. The smoke evacuator or room suction hose nozzle inlet must be kept within 2 inches of the surgical site, and the smoke evacuator should be on at all times when airborne particles are produced. Smoke evacuator tubing, filters, and absorbers must be considered infectious waste and be disposed of appropriately.

<http://www.cdc.gov/niosh/docs/hazardcontrol/hc11.html>

Joint Commission

Environment of Care Standard EC.02.02.0—Element of Performance (EP) 9

The standard states that the hospital manages risks related to hazardous materials and waste. EP 9 says the hospital minimizes risks associated with hazardous gases and vapors.

In 2009, the Joint Commission added a note for clarification, saying that hazardous gases and vapors include, but are not limited to, glutaraldehyde, ethylene oxide, vapors generated while using cauterizing equipment and lasers, and gases such as nitrous oxide.

http://www.jointcommission-connect.org/NR/rdonlyres/AE4E70B4-7FA3-4D25-885E-C7B8212E7E15/0/BP_Hazardous-WasteFINALlinked.pdf

a University of Minnesota study questioned whether they live up to their specifications, says Dr Schultz. “They trap the big stuff, but as much as 5% to 10% of nanoparticles pass through the filter back into the OR.”

Central vacuum suction is 45 cubic feet per minute or more—25 to 35 cubic feet per minute is needed for effective smoke evacuation.

Central vacuum systems are available in the US and are already installed in about 50 hospitals, says Dr Schultz. They don’t rely on filters and will pay for themselves in 2 years, he says.

As healthcare workers become more knowledgeable about the adverse effects of surgical smoke, they are going to be asking hospital administrators why they are not following guidelines and protecting them adequately. This will force administrators to start looking at their potential liability, says Dr Schultz.

“This could be huge,” he says. “If you think asbestos and mesothelioma cost a lot at \$30 billion, think about the numbers of workers who have been exposed to surgical smoke who could join in a class-action suit.”

Many large hospital systems are self insured, and they will be responsible for those claims—if not frank liability, civil liability.

“When you start getting into the big picture, you start to realize that it is a much bigger story than simply getting smoke out of the operating room,” he says. ❖

—*Judith M. Mathias, MA, RN*

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