

# Surgical Smoke: What We Know

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Although the long-term effects for healthcare workers exposed to surgical smoke remains unknown, there is a need to be proactive and prevent any potential harm. Engineering controls and personal protective equipment should be used to protect all staff and patients from exposure to smoke by-products. Understanding the environmental hazards related to surgical smoke and aerosols produced during all operative and invasive procedures is a critical first step in the implementation of adequate protective measures for both patients and perioperative personnel.

Surgical smoke is part of the patient-care environment wherever surgical and/or invasive procedures are done. It has been described as part of the chemical soup that is present during the care of perioperative patients. The air quality in operating rooms around the world has been a concern for over three decades (Rothrock 2007).

## What is Surgical Smoke?

Surgical smoke is called by a variety of names, including cautery smoke, diathermy plume, plume, smoke-plume, aerosols, bio-aerosols, vapour and air contaminants. It can be seen and smelled (Ott 1997).

## How is Smoke Produced?

Tools to achieve haemostasis and dissection include electrosurgery units, lasers, ultrasonic devices, high-speed drills, burrs and saws. All of these devices produce heat, which allows the surgeon to achieve the desired tissue effect. The most common device used is the electrosurgery unit. Electrosurgery uses high-frequency current to cut and coagulate tissue. The disruption releases the cellular fluid as steam and spews the cell contents into the air forming surgical smoke plume.

Lasers are the second most common heat-producing device. Lasers produce high heat that boils and explodes the cells. This cellular vaporisation releases steam and cell contents (Anderson 2004). When the particulate matter of both laser and electrosurgical smoke are compared they are very similar, as identified by ECRI (1990). Facility policies on smoke evacuation should be the same for electrosurgery units and for lasers (ECRI 1990).

## Contents of Surgical Smoke

Barrett and Garber identified a long list of chemicals present in surgical smoke. Two of the chemicals of concern were acrylonitrile and hydrogen cyanide. Acrylonitrile is a volatile, colourless chemical that can be absorbed through the skin and lungs. Acrylonitrile liberates hydrogen cyanide. Hydrogen cyanide is toxic, colourless and can also be absorbed into the lungs, through the skin and via the gastrointestinal tract (Barrett & Garber 2004).

## The Best Defence against Smoke

Former AORN Journal Editor Brenda Gregory Dawes stated in 2000 that a 'stop smoke campaign begins with you'. 'Use available tools and knowledge to minimize exposure to surgical smoke. Until there are regulations that reduce the occupational hazard of surgical smoke become an expert in what can be done' (Dawes 2000).

## Smoke Evacuation System

Portable smoke evacuation systems are presently the most versatile choice for operating rooms. The most effective smoke evacuation system is equipped with an ultra-low penetration air (ULPA) filter. ULPA filters capture 0.12 micron particulate matter at an efficiency rate of 99.9999 percent. At that rate only one in 1 million particles will escape capture (Ulmer 2008). The system is made up of a prefilter that captures large particles. The ULPA filter is the second stage of the filter, and captures the smaller particle components of smoke. The third filter is made up of a special charcoal that captures the toxic chemicals found in smoke. An effective portable smoke evacuation system should be able to pull 30 to 50 cubic feet per minute (CFM) to be able to capture surgical smoke (ECRI 2007).

## Recommended Practices, Guidelines, Standards, and Regulations

The need to evacuate and appropriately filter surgical smoke is being recognized around the world as countries move to provide a safer environment for perioperative personnel and patients.

### Nordic Countries

The guidelines in the Nordic countries are currently one of the most prescriptive on surgical smoke. Translated, the document states:

- 'Comparisons between laser smoke and diathermy smoke (electrocoagulation) show that even diathermy smoke can contain insanitary substances, and measures should be taken to eliminate such smoke.' (Rapport: 1994: 1)

### Conclusions

- Smoke, produced at surgical treatment with carbon dioxide laser, must be treated as insanitary and the risk of contamination cannot be eliminated.
- Generated smoke is quickly spread in the air of the operating room. A well designed point aspiration device is required to prevent this, including a filter to be changed regularly. Preferably a filter guard should be installed to ensure that the required filter capacity is always maintained.
- The filters should be treated as hazardous waste and routines for waste management are required. If sufficient ventilation cannot be arranged, concerned personnel should be protected with adequate respirators (Rapport: 1994: 1)

### United Kingdom

The British Occupational Hygiene Society (BOHS) has developed a guidance document on surgical smoke to be used by managers in the National Health Service. The document acknowledges the harmful effects of the contents of surgical smoke and recommends that local exhaust ventilation (LEV) be used to evacuate and filter the smoke:

'Theatres usually have high rates of general ventilation. This does not, however, prevent the emission of smoke into the room or the exposure of staff. Local exhaust ventilation (LEV) is required to achieve this. The known irritancy, the other hazardous properties of the component contaminants, and the persistent concerns of chronic effects combine to lead to the conclusion that effective LEV should be considered a required control measure' (BOHS 2006).

### Canada

The Canadian Standards Association (CSA) has developed a very detailed standard for smoke evacuation in Canada. The document identifies the dangers of surgical smoke and goes into significant detail about the importance of evacuating and filtering smoke/plume wherever it is produced (CSA 2009).

## World Nursing Organisations

### The Association for Perioperative Practice (AfPP)

AfPP is a registered charity working to enhance skills and knowledge within operating departments, associated areas and sterile services departments. It aims to enhance the quality of care in the National Health Service and the independent sector throughout the UK. AfPP also works to encourage the exchange of professional information between members and cooperation with other professional bodies. These include the Departments of Health, the Perioperative Care Collaborative, the medical Royal Colleges, Chief Nursing Officers of all four member countries, Skills for Health and many of the British Safety Institution Committees and other groups set up to discuss specific issues.

In AfPP's *Standards and Recommendations for Safe Perioperative Practice*, Standard 2.6 Lasers states: 'Dedicated smoke evacuation machines must be used to remove the smoke...' (AfPP 2007).

### Association of periOperative Registered Nurses (AORN) United States of America

AORN Standards and Recommended Practices have called for evacuating and filtering surgical smoke (AORN 2009).

An April 2008 Position Statement recognizes that surgical smoke is a hazard to perioperative personnel and urges the use of personal protective equipment and evacuation and filtration of smoke. The statement further says that perioperative personnel should be educated about the dangers of surgical smoke to increase awareness of the need to evacuate and filter smoke (AORN 2008).

### Australian College of Operating Room Nurses (ACORN)

ACORN represents professional nurses across Australia. The organisation practice guidelines include recommendations on smoke evacuation:

**Principle:** The prevention of patients' and healthcare personnel's exposure to surgical plume and smoke is recommended:

- Personnel shall utilize appropriate equipment and procedures to prevent exposure to surgical plume
- Exposure to surgical plume shall be minimized during the surgical procedure
- Surgical smoke capture devices shall be available for use during procedures in which surgical smoke is generated (ACORN 2006).

### The International Federation of Perioperative Nurses (IFPN)

IFPN is a world wide organisation whose members are perioperative organisations in countries around the world. In July 2007, IFPN adopted a guideline aimed at protecting perioperative personnel for surgical smoke:

'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 and that such policies also comply with workplace health and safety laws, or other legislative guidance, and with International Electro-technical Commission (IEC), standards pertinent to the particular healthcare setting' (IFPN 2007). The guideline can be accessed at [www.ifpn.uk.org](http://www.ifpn.uk.org).

### Operating Room Nurses Association of Canada (ORNAC)

ORNAC is the organisation representing perioperative nurses throughout Canada. The Canadian surgical smoke recommended practice states: 'Whenever electrosurgery is used, it should be used in conjunction with a smoke evacuator' (ORNAC 2007).

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