

# Management of surgical smoke plume in the perioperative environment



The following extract is taken from *Standards and Recommendations for Safe Perioperative Practice (Fifth Edition)*, Risk Management (Section Two), pages 107 to 109, published by The Association for Perioperative Practice.

## STANDARD

There is a smoke plume evacuation management system in place, supported by local protocol and procedures to establish a safe environment for the surgical patient and the perioperative team. Practitioners employed in the perioperative environment have an understanding and awareness of the issues relating to smoke plume, which informs their practice and ensures patient and personnel safety. That surgical smoke plume evacuation systems should always be activated while smoke plume is being generated.

Surgical smoke is the broad term used for several gaseous by-products produced by energy-based surgical instruments. The definition of smoke refers to the products of combustion, whereas vapour, aerosol, and mist refer to the suspension of liquid particles. Electrocautery devices are described as creating a 'plume' of smoke, whereas ultrasonic devices and high-speed drills (Ulmer 2008) are described as creating vapours, aerosols, and mists (Mowbray et al 2013).

## Background

Diathermy smoke plume has been studied for many years (Sagar et al 1996), the current body of scientific knowledge and research lists a long line of hazardous substances and harmful elements. These may be broken down into different constituents; chemical, biological, and physical (Kocher et al 2019). It is the unnecessary occupational exposure to these by-products by the perioperative team, and the patients, which can cause lung-damaging conditions (AORN 2019).

All healthcare professionals working in the perioperative environment are exposed to surgical smoke plume each day in the UK. This is one of the most overlooked hazards in the operating theatre. There is also a risk of plume escaping out of the theatre and affecting people in corridors and rooms nearby.

The composition of surgical smoke plume is approximately 95% water and 5% of other matter. It is the other 'matter' that is potentially hazardous to perioperative teams and to the patient. The other matter is known to contain chemical (toxic compounds) and biological cellular fragments (carbonised tissue, blood fragments, and bacteria), in varying amounts, depending on the tissue that is being broken down (Bree et al 2017).

## Chemical components of smoke plume

There are over 80 different chemical components which have been cited in literature as being identified in smoke plume (Pierce et al 2011, Lindsey et al 2015), some of which have been documented as being harmful to health. Some of the chemicals that have been identified are:

- **Acetaldehyde:** carcinogen, acetaldehyde liquid or vapor can affect the skin and eyes.
- **Perchloroethylene:** main component of dry-cleaning fluid, irritation of the upper respiratory tract, eyes, kidney dysfunction, neurological effects such as reversible mood behavioural changes, impairment of coordination, dizziness, headaches, and sleepiness.

- **Hydrogen cyanide:** neurotoxin used in chemical warfare.
- **Toluene:** similar to paint thinner, known carcinogen, chronic inhalation causes irritation of the upper respiratory tract, eyes, sore throat, dizziness, and headaches.
- **Formaldehyde:** used as embalming fluid and to preserve surgical specimens, potential carcinogen, if exceeds 0.1 ppm in the air can cause watery eyes, burning sensations in eyes, and throat causing coughing wheezing, nausea, and skin irritation.
- **Ethylbenzene:** used in the manufacture of Styrofoam, carcinogen, when inhaled may damage the liver, can cause irritation of the nose and throat, in high concentration, headaches, dizziness, and light-headedness.
- **Benzene:** known potential carcinogen, long-term exposure at high levels in the air can cause leukaemia, and cancer of the blood forming organs.

Hill et al (2012) identified that routine use of diathermy in a plastic surgery theatre exposed staff and patients to an equivalent of 27-30 cigarettes daily.

## Biological matter

This is the particulate matter that contains blood, and potentially infectious viruses and bacteria. The water vapour created by heat generating devices enables these minute particulates to be carried in the environment through aerosolization, which can transfer infections.

The collective evidence indicates that particles within surgical smoke plume are in the respirable range. Electrosurgery (diathermy) generates the smallest aerodynamic size particles (<0.07µm to 0.1µm); laser tissue ablation creates larger particles (~0.31µm), and ultrasonic scalpels create the largest particles (0.35µm to 6.5µm) (AORN 2019).

Surgical smoke plume may contain as much as three to 51 parts per million hydrogen cyanide, two to eight parts per million acetylene, and 0.15 to 0.69 parts per million 1:3 - butadiene (Moot et al 2007).

## Physical

The physical components are ultrafine particles which create a very fine dust in the atmosphere (aerosols) and if inhaled can bypass the usual filtration process in the lungs (Bree et al 2017).

## Relevant legislation

The Control of Substances Hazardous to Health Regulations (COSHH 2002) and the COSHH Amendment Regulations 2004 (see also HSE 2012b), require that risk assessments be undertaken to ensure that minimising the risk at source is done to prevent as much exposure as possible.

Any risk assessment undertaken under COSHH arrangements would signal actions for the prevention, identification and, where possible, control of adverse outcomes that may arise from smoke plume in the operating room environment.

Avoiding smoke exposure and protecting healthcare professionals in the perioperative environment can be achieved by local organisations providing mechanical local exhaust ventilation (LEV) devices which attach directly to electrosurgical equipment. Staff education and provision of personal respiratory masks is key to protect practitioners most at risk from aerosolized particulate contaminants found in smoke plume (Conner et al 2014).

It is the responsibility of the employing organisation under the Health and Safety at Work Act 1974 (HASAWA) to inform all perioperative practitioners of the associated hazards and risks caused by exposure to smoke plume and reduce the risks wherever possible. Guidance should be provided of how to establish a safe environment for the patient and the surgical team. Recognising that under the HASAWA 1974 employers should ensure, where practicable, the health, safety, and welfare of all their employees whilst at work.

It is the employer's responsibility to ensure that staff have been informed about all hazardous substances within their working environment and of the procedures to manage and prevent injury from those substances.

### References and further reading

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