WALKER FILTRATION

The Risks of Surgical Smoke and The Importance of Smoke Evacuation

Laservac™

Electro & Laser Surgery Smoke Evacuation System

Contents

Who should read this guide?

Anyone exposed to surgical smoke plume, including;

- Nurses
- Surgeons
- Theatre staff
- Aesthetic doctors
- Dermatologists
- Dentists
- Vets

The purpose of this brochure is to summarise and clarify the key facts about surgical smoke and the potential harm to health care workers, as well as making recommendations for both staff and patient protection.

What is Surgical Smoke?

"Surgical plume is the smoke which is generated when an electrosurgery laser or ultrasonic device is used on body tissue. Surgical plume contains toxins such as chemicals, carbonised tissue, blood particles, viral DNA particles and bacteria."

The Association for Perioperative Practice (AfPP) [1]

Composition of Surgical Smoke Plumes

Smoke plume is made up of 95% water, which acts as a carrier, and 5% cellular debris in the form of particulate matter.

This particulate can contain:

- Chemical byproducts
- Viral DNA
- Airborne infectious particles
- Bacteria and potential viruses
- Blood aerosols
- Unpleasant odours
- Steam contaminants
- Tissue vapours

There are numerous compounds yet to be identified in surgical smoke; however, Barrett and Garber[2] have identified a long list of chemicals present in surgical smoke plume, some of which are known carcinogens:

Acetonitrile	Furfural
Acetylene	Hexadecanoic acid
Acroloin*	Hydrogen cyanide
Acrylonitrile*	Indole
Alkyl benzene	Methane
Benzaldehyde	3-Methyl butenal
Benzene*	6-Methyl indole
Benzonitrile	4-Methyl phenol
Butadiene*	2-Methyl propanol
Butene	Methyl pyrazine
3-Butenenitrile	Phenol
Carbon monoxide	Propene
Creosol	2-Propylene nitrile
1-Decene	Pyridine
2,3-Dihydro indene	Pyrrole
Ethane	Styrene
Ethyl benzene	Toluene*
Ethylene	1-Undecene
Formaldehyde*	Xylene

** Known carcinogen*

Why Evacuate Surgical Smoke Plume?

The primary risk of surgical smoke plume for health care professionals and patients is inhalation, as surgical smoke poses significant risk as a respiratory tract irritant and mutagen, and as a vector for infectious particles[18] - Smoke plume is made up of both noninfectious and infectious particulate matter. Particles that are 5 microns or larger are deposited on the walls of the nose and throat, whilst particles that are smaller than 2 microns are deposited in the bronchioles and alveoli region of the lungs. Viruses are the smallest in size, ranging from around 0.01 to 0.3 microns[3] and it has been found that viruses in surgical smoke can remain viable for up to 14 days[7]:

Potential Risk of Smoke Plume Inhalation:

Noninfectious hazards

Tissue pyrolysis and destruction leads to release of toxic gases that impart a noxious odour to the surgical smoke plume. The chemical compounds of which can result in the following:

- Eye irritation
- Nausea/Vomiting
- Headache
- Hypoxia/dizziness
- Weakness
- Sneezing
- Throat irritation
- Lacrimation
- Light headedness
- Colic

Long term exposure

Longer term exposure to chemical compounds found in surgical smoke can also result in:

- Acute and chronic inflammatory
  (e.g. Emphysema, asthma, chronic bronchitis, interstitial pneumonia and Rhinitis)
- Carcinogenesis
- Cardiovascular dysfunction
- Cardiopulmonary disease
- Dermatitis
- Leukemia
- Nasopharyngeal lesions

Viability and infectious hazards

Presence of infectious particles in surgical smoke and viral transmission is also a potential risk, with vaporous debris from CO2-laser-treatment showing the presence of:

- HIV proviral DNA
- Human papillomavirus
- Hepatitis
- Staphylococcus
- Corynebacterium
- Neisseria

Absorption Health Risk:

In addition to inhalation risks, smoke plume presents a further risk for patients during laparoscopic surgery. As smoke is produced inside the abdomen, it is absorbed through the peritoneal membrane and into the patient's bloodstream. The subsequent result is an increase in methemoglobin and carboxyhemoglobin concentrations, which produce falsely elevated oxygen readings that can result in unrecognised hypoxia.

Case studies

Study 1

Tomita et al [5] used a CO_2 laser on a canine tongue, collecting the smoke plume generated on a glass filter paper. Through observing this collection, it was determined that the mutagenic potency of the smoke plume was highly comparable to that of cigarette smoke.
Through further observation it was concluded the smoke from 1g of vaporised tissue had the same mutagenicity as three to six cigarettes, with electrocautery smoke having twice the mutagenicity as laser smoke.

Study 2

The risk that laser surgeons may inhale virus particles from laser vapour during operations has been pointed out in many publications. Hallmo and Naess [6] examine the case of a laser surgeon developing laryngeal papillomatosis. After tissue analysis, it was identified that this contained human papillomavirus DNA types 6 and 11.

It was revealed that the surgeon had given laser therapy to patients with anogenital condylomas, which are known to host the same viral types, making the implication that the papillomas in the surgeon may have been caused by inhaled virus particles from the laser smoke plume.

Study 3

Baggish et al [7] used a CO_2 laser to vaporise tissue containing concentrated amounts of human immunodeficiency virus (HIV). The smoke plume was evacuated using a silastic tube attached to a commercial smoke evacuator. Although no DNA was detected in samples taken from the inside of the smoke evacuator, culture studies of the collection in the silastic tube revealed HIV positive DNA in 3 of 12 tube segments 7 days after the surgery and 1 of 12 segments 2 weeks after surgery.

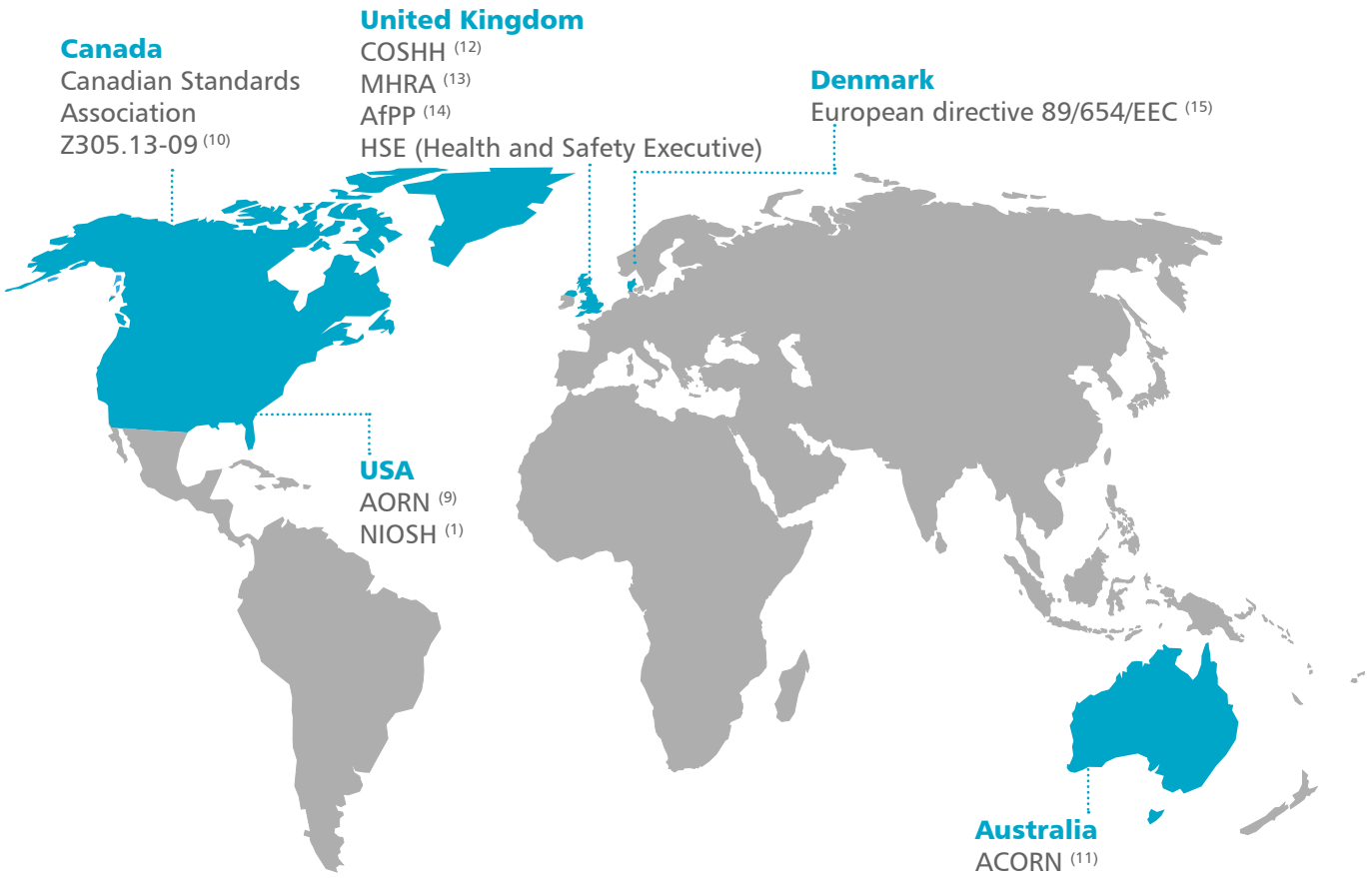
Although the smoke plume itself was not examined for the presence of HIV, Baggish et al made the assumption that it was highly likely and in the presence of an HIV positive patient, increased precaution should be taken to ensure all smoke plume is evacuated efficiently.

Study 4

A recent survey in the USA [8] showed perioperative nurses to have an increased prevalence rate of respiratory conditions than the average person in the general public. In some instances nurses showed twice the prevalence.

Global Awareness and Regulation

Laser and electrosurgery are common practice in modern medicine and internationally there is a growing awareness of the hazards of smoke plume. Some countries now have regulation in place and many health bodies publish clear recommendations for smoke plume management:



United Kingdom

The Control of Substances Hazardous to Health Regulation (COSHH) (12) requires exposure to substances hazardous to health are adequately controlled. The Medicines and Healthcare products Regulatory Agency (MHRA) (13) recommend smoke evacuation systems are used during laser surgery. It specifies masks and OR evacuation systems are not suitable for protection. The HSE (Health and Safety Executive) also advise that in order to lower the risks caused by surgical smoke plume a smoke evacuation system, such as Laservac, should be used. (15) The Association for Perioperative Practice (AfPP) state that dedicated smoke evacuators must be used and the filters checked and changed regularly in line with manufacturers recommendations.

US

The Association of periOperative Registered Nurses (AORN) (19) position statement recommends the use of a smoke evacuation system.The National Institute for Occupational Safety and Health (NIOSH) (1) issued Hazard Controls No. 11 document, recommending evacuation and filtration of smoke plume.

Australia

The Australian College of Operating Room Nurse (ACORN) (11) practice guidelines recommend prevention of patients and healthcare staff's exposure to smoke plume by means of smoke evacuation equipment.

Canada

The Canadian Standards Association (10) implemented regulation Z305.13-09 in 2009 covering all smoke emitting surgeries,requiring the use of a smoke evacuation system.

Denmark

The European directive 89/654/EEC (15) is implemented as regulation with specific provisions concerning the elimination of polluted air from any work place.

International

ISO 16571:2014 Systems for evacuation of plume generated by medical devices. International standard that specifies requirements and guidelines for the design, manufacture, installation, function, performance, maintenance, servicing, documentation, testing and commissioning of equipment for evacuation of plume generated by medical devices.

The Solution: Laservac™ Smoke Evacuation Systems

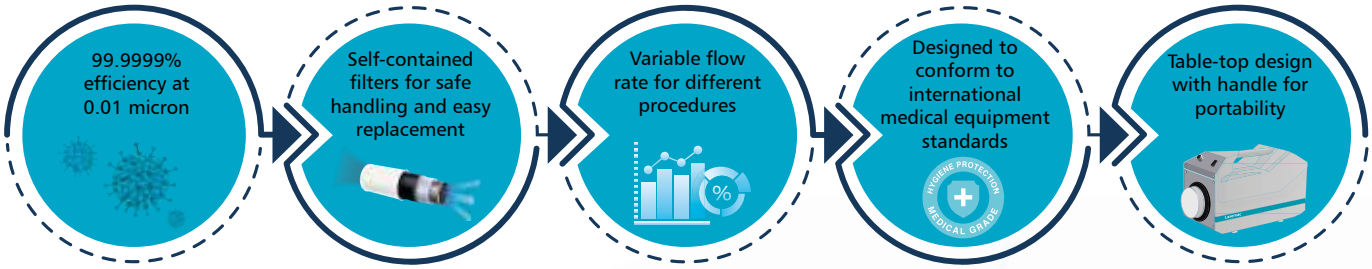
What is a Smoke Evacuation System?

"Surgical smoke evacuation systems are high-flow vacuum sources used to capture, at the surgical site, the smoke aerosols and gases generated during the use of lasers and electrosurgical units (ESUs)." - National Center for Biotechnology Information"

Smoke evacuation units are generally considered to be the most effective form of protection against the dangers of smoke plume. High efficiency filtration is the key to successful plume removal. The most effective systems offer efficiencies of 99.9999% at 0.01 micron, a rate which means only one in a million particles will escape. Suction should be placed as close to the surgery site as possible to ensure a high capture rate.

Laservac Smoke Evacuation Systems offer a versatile smoke plume management solution for today's operating environments in clinics and theatres. Walker Filtration recognised a requirement within the medical sector for effective smoke evacuation and developed the Laservac™ product range. Filtration is achieved in three stages – by air passing through a pre-filter and a two stage, high efficiency filter combining ULPA grade media and activated carbon.

The combined effectiveness of the total filtration package provides an efficiency of >99.9999% at 0.01 micron. The highest standards of quality are vital for equipment of this nature. Each Laservac filter is individually tested to ensure performance and filtration integrity to the highest standards. All electrical controls are safe for medical use and conform to IEC 60101.



About Laservac Smoke Evacuators

Walker Filtration knows filtration; it's a core competence that separates us from the competition.

At the heart of every Laservac smoke evacuation system is a high efficiency three-stage filtration system. Two individual filters; a primary filter and a secondary 2-stage filter make-up the filtration system.

The Primary Filter

The optimised primary filter acts as a pre-filter to the secondary filter, protecting it from gross particulate contamination.

Borosilicate microfibre filter media is pleated to provide a large surface area for depth filtration, as well as low pressure loss, guaranteeing a burn time of up to 3 hours.

Laservac primary filters are completely self-contained units for safe removal and replacement to protect the user from bacterial and viral contamination. Through clear casing, the user can see the filtered contamination, as shown below.

The Secondary Filter

The secondary filter is a high efficiency 2-stage filter that collects 99.9999% of particles down to 0.01 micron in size. It features both borosilicate microfibre filter media for particulate removal and activated carbon media to remove noxious smells and odours.

Like the primary filter, it is a completely self-contained unit for safe removal and replacement. The secondary filter should be replaced after 6 months to ensure safe operation and protection of health care professionals and patients alike.

High efficiency filtration is the key to successful plume removal.

Primary Filter as new Primary Filter after 6 hours use

References

1. AfPP (2011) Standards and Recommendations for Safe Perioperative Practice (2011). Third edition. Association for Perioperative Practice.

2. Ulmer, Brenda C. (April 2008.) The hazards of surgical smoke. AORN Journal. Vol. 87 (4), pp. 721 –738.

3. Tomita Y, Mihashi S, Nagata K, et al. (1981). Mutagenicity of smoke condensates induced by CO2-laser irradiation and electro cauterization. Mutation Research. Vol. 89, pp. 145-149.

4. Ball, K. Smoke overview [online]. Available at: http://www.becomenasti.com/content/ smoke-info.htm [Accessed on 19th May 2011].

5. Alf E, Bijl D, Bleichrodt RP, Hansson A, Voss A. (2006) Surgical smoke and infection control. Journal of Hospital Infections. Vol. 62 (1), pp. 1-5.

6. Hallmo P & Naess, O. (1991.) Laryngeal papillomatosis with human papillomavirus DNA contracted by a laser surgeon. European Archives of Otorhinlryngology Vol. 248, pp. 425-427.

7. Baggish M, Poiesz B, Joret D, Williamson P & Refai A. (1991) Presence of Human Immunodeficiency Virus DNA in Laser Smoke. Lasers in Surgery and Medicine Vol. 11, pp. 197-203.

8. Ball, K. (2009.) Surgical smoke evacuation guidelines – compliance among perioperative nurses. PhD dissertation, Richmond Virginia.

9. AORN Position Statement – Statement on Surgical Smoke and Bio-Aerosols, approved by House of Delegates, Anaheim, CA. April 2008.

10. CSA (2009) Surgical diagnostic, therapeutic, aesthetic plume scavenging Z305.13. Mississauga, Ontario, Canadian Standards Association.

11. ACORN (2006) Standards/Surgical Plume. Australian College of Operating Room Nurses.

12. COSHH (2002) Working with substances hazardous to health.

13. DB 2008 (03) Guidance on the safe use of lasers, IPL systems and LEDs. MHRA.

14. AfPP (2007) Standards and Recommendations for Safe Perioperative Practice. Lasers 2.6 Harrogate, AfPP 62-66.

15. Directive 89/654/EEC [online] Available at: http://osha.europa.eu/en/legislation/directives/workplaces-equipment-signs-personal-protective-equipment/osh-directives/2n [accessed on 16th May 2011].

16. Health and Safety Executive (HSE) - Evidence for exposure and harmful effects of diathermy plumes (surgical smoke) [online] Available at: https://www.hse.gov.uk/research/rrpdf/rr922.pdf

17. J Cutan Aesthet Surg. 2019 Jan-Mar; 12. Surgical Smoke in Dermatology: Its Hazards and Management

18. Citation: Lewin JM, Brauer JA, Ostad A. Surgical smoke and the dermatologist. J Am Acad Dermatol. 2011;65:636–41

Useful Websites

American National Standards Institute (ANSI) - www.ansi.org

Association for Perioperative Practice (AfPP) - www.afpp.org.uk

Association of periOperative Registered Nurses (AORN) - www.aorn.org

Australian College of Operating Room Nurses (ACORN) - www.acorn.org.au

Canadian Centre for Occupational Health and Safety (CCOHS) - www.ccohs.ca

Canadian Standards Association (CSA) - www.csa.ca

Control of Substances Hazardous to Health (COSHH) - www.hse.gov.uk/coshh

European Commission – www.ec.europa.eu

Medical and Healthcare products Regulatory Agency (MHRA) - www.mhra.gov.uk

National Institute for Occupational Safety and Health (NIOSH) - www.niosh.com

Nurses advocating smoke-free theatres immediately - www.becomenasti.com

Occupational Safety and Health Administration (OSHA) - www.osha.gov

Health and Safety Executive (HSE) - https://www.hse.gov.uk/

US National Library of Medicine - https://www.nlm.nih.gov/

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