The risks of surgical smoke

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
- Dentists
- Vets

The purpose of this brochure is to summarise and clarify the key facts about smoke plume, as well as making recommendations for both staff and patient protection.

Definition

"Surgical plume is the smoke which is released 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]

Sources

Smoke plume is the by-product of heat producing devices, including [2]:

- Lasers
- Electrosurgical units
- Ultrasonic scalpels

Composition

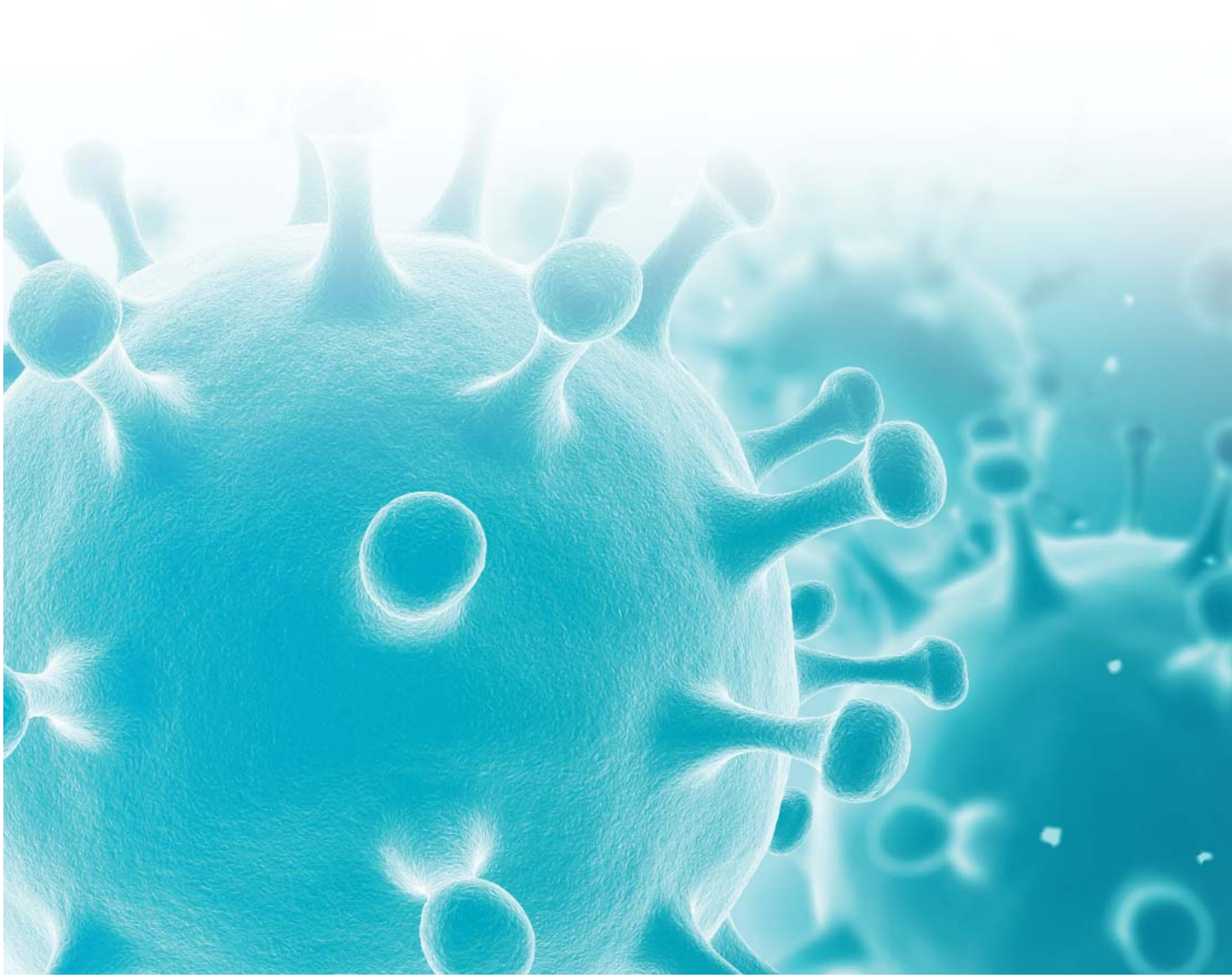
Smoke plume is made up of 95% water, which acts as a carrier and 5% cellular debris in the form of particulate matter. This particulate can contain:

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

Particle size

Each type of heat producing device creates a different size particle in its plume and the smaller the particle size, the further it can travel [3].

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 gas-exchange region of the lungs. Viruses are the smallest in size, ranging from around 0.01 to 0.3 microns.



Chemical composition

Barrett and Garber [3] have identified a long list of chemicals present in surgical smoke plume, as listed below:

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

** Known carcinogen*

Why evacuate it?

Inhalation Health Risk

The primary risk for healthcare professionals is inhalation of smoke plume. Particulate deposits can form in the nose, throat and gas-exchange region of the lungs, resulting in further complications as listed below [6]:

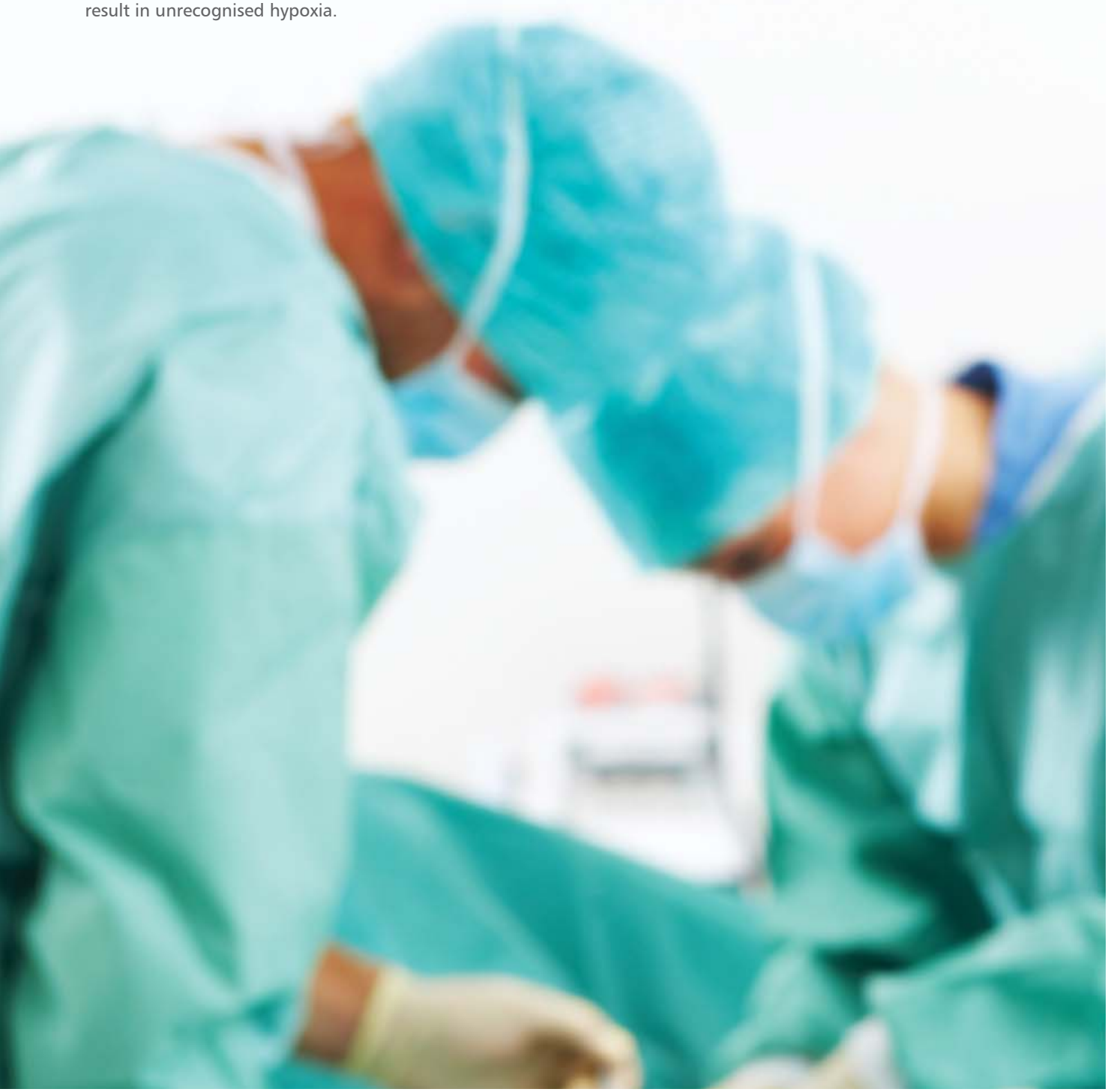
- Acute and chronic inflammatory respiratory changes
  (e.g. Emphysema, asthma, chronic bronchitis)
- Hepatitis
- Anaemia
- Anxiety
- Carcinoma
- Cardiovascular dysfunction
- Colic
- Dermatitis
- Eye irritation
- Headaches
- HIV
- Hypoxia/dizziness
- Lacrimation
- Leukaemia
- Nasopharyngeal lesions
- Nausea/vomiting
- Sneezing
- Throat irritation
- Weakness

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.

Visibility Problems

Smoke plume can cause reduced visibility problems, particularly during minimally invasive procedures, as well as procedures where there is significant tissue ablation [5]. This not only slows down the operation, but adds an increased risk of complications.



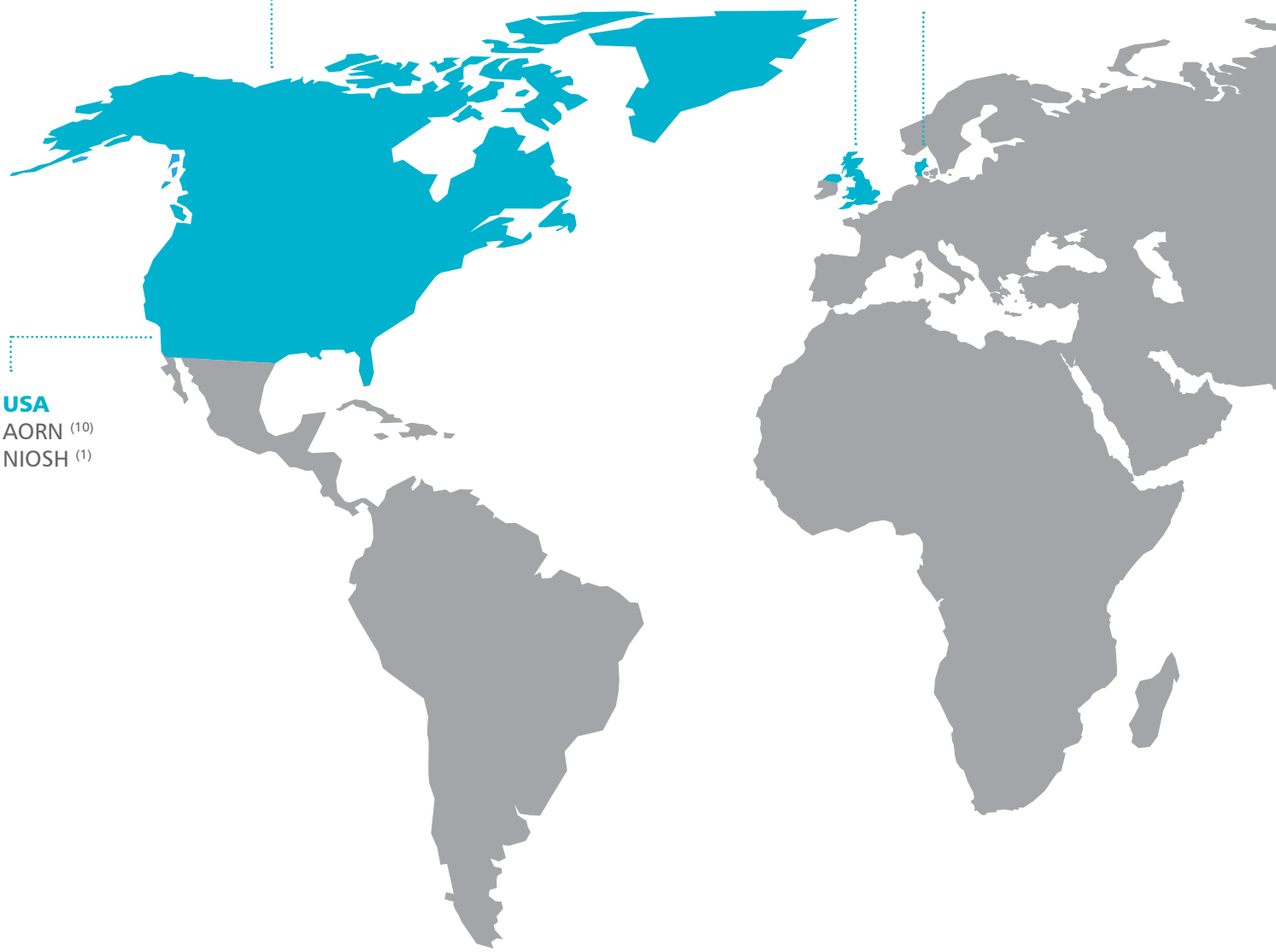
Global awareness and regulation

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
COSHH [13]
MHRA [14]
AfPP [15]

Canada
Canadian Standards Association Z305.13-09 [11]

Denmark
European directive
89/654/EEC [16]



USA
AORN [10]
NIOSH [1]

Australia
ACORN [12]

Australia

The Australian College of Operating Room Nurse (ACORN) [12] 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 [11] 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 [16] is implemented as regulation with specific provisions concerning the elimination of polluted air from any work place.

United Kingdom

The Control of Substances Hazardous to Health Regulation (COSHH) [13] requires exposure to substances hazardous to health are adequately controlled.

The Medicines and Healthcare products Regulatory Agency (MHRA) [14] recommend smoke evacuation systems are used during laser surgery. It specifies masks and OR evacuation systems are not suitable for protection.

The Association for Perioperative Practice (AfPP) [15] recommend smoke evacuation. Filters must be checked and changed in line with manufacturers recommendations.

USA

The Association of periOperative Registered Nurses (AORN) [10] 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.

Case studies

Study 1

Tomita et al [4] 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 [7] 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 [8] 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 [9] 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.

How to reduce exposure

Policy & Procedures

All smoke plume management practices should be written into a formal policy and include safety instructions and guidelines. The policy documents should be well communicated and available to all healthcare staff.

Surgical Masks

Surgical masks can provide a degree of protection from smoke plume, dependent on the filtration efficiency. Standard surgical masks provide filtration of particles larger than 5 microns whilst high filtration masks (also known as laser masks) filter particles to approximately 0.1 microns.

Whilst wearing high filtration masks does provide some respiratory protection, viral particles can be much smaller than 0.1 microns. Other common problems include diminished effectiveness from masks worn too loosely or for long periods of time.

Smoke Evacuation Systems

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.

The solution

Laservac smoke evacuation systems

Walker Filtration is a British company specialising in filtration and drying solutions. The Laservac concept evolved as a result of extensive research and development over the last 30 years working closely with both end users and manufacturers of medical laser and electrosurgical products. Applying core filtration knowledge and expertise, the Laservac range was developed to reduce the risks of laser and electrosurgery in order to protect medical staff and their patients.

Laservac smoke evacuators offer versatile smoke plume management for today's operating environments, providing peace of mind and clinical safety for both patients and healthcare staff.

Laservac 750™

- Highly efficient 3 stage filtration system; 99.9999% efficient at 0.01 micron
- Self contained filters for safe handling
- Variable flow rate for different procedures
- Pneumatic foot switch for remote control
- Table top design with handle for portability
- Range of accessories to support different procedures
- Suitable for 220v and 110v operation

Filtration

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; the primary and secondary, 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. This means that a high flow volume, and therefore suction is maintained during surgery guaranteed for up to 6 hours use.

Laservac primary filters are completely self-contained units for safe removal and replacement. 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 borosilicate microfibre filter media for particulate removal and activated carbon media removes noxious smells and odours.

Like the primary filter, it is a completely self-contained unit for safe removal and replacement. The secondary filter has a lifespan of 6 months.

Complete environment conditioning is achieved through the Laservac filtration systems, making laser and electrosurgical procedures safe and hygenic.

Primary Filter as new

Primary Filter after 6 hours use

High quality manufacture

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.

All Laservac equipment is manufactured in the UK in facilities accredited to ISO 9001.

References

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

2. Scott, E.; Beswick, A. and Wakefield K (2004). The hazards of diathermy plume. British Journal of Perioperative Nursing. Vol. 14 (9), pp. 5-12.

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

4. 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.

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

6. 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.

7. 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.

8. 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.

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

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

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

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

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

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

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

16. 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].

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

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