Laser-generated Airborne Contaminants

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This month's installment of Laser Safety discusses the generation, contents, risks, and means of protection from laser-generated airborne contaminants. Laser-generated airborne contaminants can form during disruption of tissue cells by heat (lasers, electrosurgical generators), mechanical manipulation (rotary devices, saws), or ultrasonic instruments. This disruption can cause the release of plume, which may contain viable bacteria, viruses, cellular debris, particulates, noxious and toxic aerosols, gases, vapors, or fumes. Additional chemicals can be released when energy-based procedures contact tubing, swabs, and skin-preparation solutions.

Escherichia coli, *Staphylococcus aureus*, human papillomavirus, human immunodeficiency virus, and hepatitis B virus have been found in laser plume. Many different chemicals have also been found in plume including, carbon monoxide, hydrogen sulfide, ammonia, toluene, styrene, phenol, benzyl cyanide, and hydrocyanic acid.

There is little difference in the contents of the plume whether generated by laser or electrocautery, but certain infectious agents may be more widely distributed secondary to laser as compared to electrocautery.

The size and distribution of the generated particles depend on numerous factors, such as the type of laser being used, the amount of lasing being performed, the surgical technique, the type of procedure, and the organ being lasered. Laser plume particles can range in size from 0.1 to 2.0µm. The term *lung-damaging dust* refers to particle size ranging from 0.5 to 5.0µm. Laser treatment of warts has been associated with an increase risk of warts in laser operators and a case of laryngeal papillomas in a laser surgeon has been reported. At the very least, the contents of plume can irritate the ocular and nasal mucosa.

In order to protect staff and patients, the Canadian Standards Association (CSA) requires that all operators are trained in the appropriate use of the plume scavenging systems (PSS), have access to current plume hazard and safety information, and annually demonstrate competency in the use of PSS equipment. The scope of the Canadian regulations applies to surgical facilities, dental clinics, medical offices, cosmetic treatment facilities, and professional exhibitions and trade shows. Facilities should maintain documentation of appropriate training and annual competency evaluation.

In general, there are two techniques to protect exposed personnel—the use of ventilation and respiratory protection. Ventilation protection, which is the most important, can include protection by general room or local exhaust, or a combination. Local exhaust can include smoke evacuators or wall suction systems. Portable smoke evacuators use various filters and absorbers that require monitoring and replacement on a regular basis. These filters should be considered a possible biohazard and should be disposed of accordingly.

Commonly used filters are ultra-low penetration air filters (ULPA) and high-efficiency particulate air filters (HEPA). Many units also contain an activated carbon bed for trapping gases.

HEPA filters generally have an efficiency rating of 99.97 percent for particle size of 0.3µm (i.e., three particles out of 10,000 measuring 0.3µm will get through the filter). The ULPA filters have an efficiency rating of 99.999+ percent for particle size of 0.12µm (i.e., one particle out of 100,000 measuring 0.12µm will get through the filter).

Various attributes of smoke evacuators to consider when purchasing include, the nozzle diameter ($^7/_8$ inch is commonly available and some companies feature $1^1/_4$-inch diameter hoses), motor size, and noise levels.

The order of filter assembly is important. It should start with an efficient nozzle for complete capture of smoke at the site. A pre-filter will filter larger particles and aerosols between 3 and 20µm and an ULPA filter will filter particles down to 0.01µm. The charcoal filter should be placed last to absorb odor-containing gases.

To obtain maximum capture, the nozzle should be placed within two inches of the lasered site. There is some debate as to whether smoke evacuators are effective in collecting debris generated by Q-switched lasers, such as when a tattoo is treated with a Q-switched Ruby laser. The speed with which the particles are ejected may render the smoke evacuator inefficient in capturing these particles.

In summary, laser operators and other healthcare personnel present in the laser operating room are at potential risk from airborne contaminants. The laser safety officer and laser operator should ensure that proper scavenging systems are in place and are being used properly. ●

Information for this report was obtained from the American National Standard for Safe Use of Lasers in Health Care Facilities (ANSI Z136.3; 7.4); Canadian Standards Association monograph, Plume scavenging in surgical, diagnostic, therapeutic and aesthetic settings (CSA Z305.13-09); Arndt KA. Hazards associated with the use of lasers. In: Arndt KA, Dover JS, Olbricht SM, eds. *Lasers in Cutaneous and Aesthetic Surgery.* Lippincott-Raven; 1997; and CR Yeh. Surgical smoke plume. *Surgical Services Management*. 1997;3(4).

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