

## ECRI Institute Perspectives

# Proper safety precautions will minimize dangers posed by lasers

**D**espite their benefits, lasers pose risks no matter where they are used. Lasers expose patients and staff to hazards that can injure, disable, or kill. Patients have been severely burned by laser-ignited fires, health care staff members have been harmed by misdirected laser beams, and service personnel have been electrocuted while working within the laser's enclosure.

Health care facilities that perform laser procedures must have a comprehensive laser safety program in place to address safe equipment operation, proper use of protective equipment, fire prevention, education and training of laser operators and support staff, and credentialing of physicians who perform laser-based procedures.

### Laser hazard classification and oversight

Many organizations, regulators, and standards bodies rely on the laser hazard classification system developed by the American National Standards Institute (ANSI) in its American National Standard for Safe Use of Lasers (ANSI Z136.1).

The US Food and Drug Administration (FDA) uses ANSI's laser hazard classification system to require various manufacturers' safety features and warning labels based on the laser's class (21 CFR § 1040.10).

The Occupational Safety and Health Administration (OSHA) regulates the safe use of lasers in the workplace. While OSHA does not have a specific standard for lasers, the agency can cite organizations for failure to provide safe working conditions for staff operating lasers under its General Duty Clause, which requires employers to provide a safe workplace environment "free from recognized hazards" (29 USC § 654[a][1]; OSHA).

ANSI's American National Standard for Safe Use of Lasers in Health Care Facilities is the recognized standard for laser safety in hospitals and other health care settings (Andersen). The AORN Perioperative Standards and Recommended Practices also provides recommendations for keeping patients and users safe when lasers are in use in the perioperative setting (AORN).

### Health and safety risks

#### *Eye injuries and flashback*

Because the retina has no nerve endings and can't sense pain, harmful exposure from a laser may go undetected until considerable damage is done. Many eye injuries occur because the eye protection used is inappropriate; everyone in the laser treatment area, including the patient, must wear protective eyewear with appropriate filtering capabilities, optical density, and side shields.

Protective eyewear recommendations vary depending on the wavelength and power density of the laser energy in use. ANSI's and AORN's standards provide specific guidance on eye protection. Additionally, the laser supplier can advise on proper eyewear selection.

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Personnel must check the wavelength and optical density printed on the eyewear to confirm its appropriateness before each procedure. To minimize confusion, some facilities match the laser and appropriate safety eyewear by color coding the laser handpiece and eyewear (Bader and Lui). It is also important to inspect the laser safety eyewear before each use; a crack in the lens may allow light to be transmitted directly to the eye.

ANSI and AORN recommend that health care staff involved in laser procedures have an eye exam at the start of employment to establish a baseline level of visual performance against which damage can be assessed in the event of a laser accident. Examinations should be performed routinely during all accident investigations in which laser exposure is suspected.

To eliminate the risk of flashback (unintentional reflection of the laser beam), a thorough examination of the laser procedure area must be conducted to identify reflective surfaces, materials, and instruments that are present. All reflective materials or surfaces should be replaced, modified, or covered. AORN's standard recommends that only anodized, dull, nonreflective, or matte-finished instruments be used near the laser site.

#### ***Laser plume***

The plume of smoke produced by a laser when it interacts with tissue has an acrid smell and contains potential health hazards. At high concentrations, the smoke plume can cause ocular and upper respiratory tract irritation and can interfere with the visibility of the surgical site. Analysis of airborne contaminants has shown that the laser plume contains gas and vapors, dead and living cellular material, and viruses (National Institute for Occupational Safety and Health, NIOSH). As the laser destroys human tissue, it creates an aerosol with mutagenic and carcinogenic properties that may be capable of disease transmission (Bigony).

NIOSH recommends controlling airborne contaminants with ventilation techniques using general room and local exhaust ventilation, such as portable smoke evacuators and room suction systems. Measures for smoke and plume control are also addressed in ANSI's and AORN's standards.

#### ***Fires***

Fires caused by lasers are uncommon, but they do happen. Of the estimated 550 to 650 surgical fires that occur in health care facilities annually, about 10% involve lasers (ECRI Institute). Specific measures to minimize the risk of fires from lasers are highlighted below (ANSI Z136.3; AORN; ECRI Institute):

- Limit the laser output to the lowest clinically acceptable power density and pulse duration.
- Test the laser on a safe surface before starting the surgical procedure to ensure that the beams are aligned.
- Place the laser in standby mode whenever it is not in active use.
- Activate the laser only when the tip or aiming beam is in direct view.
- Never clamp laser fibers to drapes; clamping can break the fibers.
- When performing laser surgery through an endoscope, pass the laser fiber through the endoscope before introducing the scope into the patient. Verify the fiber's functionality before inserting the scope into the patient.
- During lower airway surgery, keep the laser fiber tip in view and make sure it is clear of the end of the bronchoscope or tracheal tube before laser emission.
- Use a laser backstop, if possible, to reduce the likelihood of tissue injury distal to the surgical site.
- Use appropriate laser-resistant tracheal tubes during upper airway surgery. Follow all directions in the product literature and on the labels.

- Place moistened gauze or sponges next to the tracheal tube cuff to protect the tube from laser damage, and keep the gauze or sponges moist.
- Consider using towels soaked in saline or sterile water around the operative site to minimize the risk of igniting the towels, as long as this will not compromise aseptic technique for the procedure.

Extreme caution is necessary when a laser is used during surgery in the airway or on the head, face, neck, or upper chest.

**Airway fires.** A laser beam or a piece of heated material on a standard tracheal tube in an oxygen-enriched atmosphere can produce an intense fire in and around the tube, which can cause extensive and life-threatening injury to a patient's air passages and lungs.

While laser safety guidelines recommend that laser-resistant tracheal tubes (LRTTs) be used during laser procedures, no LRTT is completely safe from all types of laser energy under all conditions during surgery. The manufacturer's specifications usually define the conditions under which the tube supposedly will not ignite. Inflatable cuffs at the distal end of tracheal tubes should also be considered. The cuff is not usually laser resistant because it must inflate and conform to the trachea.

**Fire response.** When any signs of a fire are present, the surgical team should halt the procedure and, if a fire is confirmed, announce that there is a fire, stop the flow of gases to the patient, remove burning materials from the patient, and care for the patient. Water or saline solution for quenching flames should be immediately available to the team.

Although fire extinguishers should not be the first choice, they may be needed in the extremely rare instance in which a fire is extensive and continues to burn on the patient, involves materials that continue to burn after being removed from the patient, or involves equipment in the treatment area. ECRI Institute and the American Society of Anesthesiologists recommend CO<sub>2</sub> extinguishers for use in the OR and other surgical settings. Staff training in the use of fire extinguishers is essential in all settings.

At the first sign of an airway fire, the surgical team should immediately disconnect the breathing circuit from the tracheal tube and remove the tube, remove cuff-protective devices and any segments of burned tube, pour saline or water into the airway to ensure that any remaining embers are extinguished and to cool the tissues, reestablish the airway, and resume ventilating with air until nothing is left burning, then switch to 100% oxygen. ECRI Institute provides 2 posters to remind staff about surgical fire prevention and response steps; they are available at [https://www.ecri.org/Surgical\\_Fires](https://www.ecri.org/Surgical_Fires).

## **Minimizing the risks**

### ***Laser safety program***

The most common deficiency of health care facilities that use lasers is the failure to establish a laser safety program with clear policies and procedures as well as oversight by a laser safety officer (Stanton). Both ANSI's and AORN's standards outline the components of the program as follows:

- Support the multidisciplinary laser safety committee and enforce policies and procedures for laser use.
- Name a laser safety officer responsible for laser safety program oversight and for the evaluation and control of laser hazards (ANSI Z136.3).
- Comply with criteria and authorization procedures for all personnel working in the laser nominal hazard zone.
- Educate and train personnel on laser hazards and measures to control them.
- Manage and report adverse events related to laser procedures to the risk manager.

### ***Area and equipment controls***

Lasers should be used only in controlled areas. Appropriate protective eyewear should be clearly marked and readily available outside the laser treatment room so laser team members can don the eyewear before entering the room. Entryways and windows in the laser use area must be covered with nonreflective material that prevents excessive laser energy from escaping the room. Doors to the laser treatment area must remain closed when a laser is in use, and signage should be posted (ANSI Z136.3).

FDA requirements for medical lasers include protective housing, automatic shutoff of the laser beam when the protective housing is opened, key control to activate the laser system, emergency shutoff buttons, and signals to alert staff to the activation of the laser beam (21 CFR § 1040.10). Health care facilities should also adopt procedures to prevent the inadvertent activation of a laser beam (AORN).

### ***Staff training and qualifications***

The responsibility for operating the laser system and monitoring its safe use should be limited to approved, trained individuals (typically physicians, laser safety nurses, and technicians).

The physician seeking privileges for laser use should demonstrate completion of a basic training program on the principles of lasers, their instrumentation and physiological effects, and safety requirements, as well as training for the specific wavelength laser to be used during the particular procedure. The American Society for Laser Medicine and Surgery Inc. (ASLMS) has developed broad guidelines for credentialing for laser use (ASLMS Standards). Safety training should be tailored to the various groups, such as laser safety nurses and technicians who will be operating the system. All training activities should be documented and maintained in personnel files.

### ***Policies and procedures***

Working with the laser safety officer, OR managers should ensure policies and procedures are in place.

**Documentation.** The perioperative record should include type of laser used; laser setting and parameters; safety measures implemented during laser use; on/off laser activation and deactivation times for head, neck, and chest procedures; and patient protection provided (eg, eyewear). AORN recommends that the facility maintain a laser log in addition to the perioperative documentation. This log should include patient information; procedure performed; laser type, model, and serial numbers; staff present; laser team members' use of protective eyewear; number of joules used; and total energy and wattage used (AORN; Andersen).

Laser safety standards also recommend that facilities use a laser safety checklist as a guide for clinical staff to ensure that safe practices are followed before, during, and after a laser procedure. Completion of the laser safety checklist should be noted in the laser log.

**Event reporting.** OR managers can help educate the laser safety team about the importance of reporting adverse events, near misses, or unsafe conditions involving a laser. The team should understand the need to impound a laser and any other equipment involved in an event and to leave the laser's control settings untouched. In many health care facilities, the OR manager will work closely with the risk manager and the laser safety officer to investigate incidents and identify measures to prevent their recurrence.

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