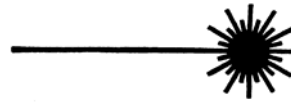


LASER SAFETY IN MEDICAL & CLINICAL APPLICATIONS AT UC IRVINE



The use of lasers in medical and clinical applications has grown considerably in recent years. Attendant to this increased use has been the need to train all of the physicians, nurses, and technicians who operate lasers, or who work in surgical rooms in which they are operated, regarding general laser safety principles. This document is intended to assist with that effort.



A. LASER SAFETY TRAINING

There are two components of laser safety training:

1. General laser safety training:

All persons who operate Class 3b and/or Class 4 research lasers on the UC Irvine main campus are required to take the *Laser Safety Online* course (www.ted.uci.edu; listed under “Catalog & Enrollment”). General laser safety principles are covered including all forms of laser safety controls, biological effects of laser radiation, frequent causes of laser accidents, non-beam hazards, and human behavioral factors as they relate to laser safety (fatigue, carelessness, hurrying, horseplay, etc.).

The UC Irvine main campus *Laser Safety Program* does not provide primary oversight for medical and clinical laser procedures performed at the Beckman Laser Institute, Gottschalk Medical Plaza, or UCI Medical Center. The UCI Medical Center Radiation Safety Office oversees those facilities. Thus, laser personnel there are not required by the main campus Laser Safety Officer to take the *Laser Safety Online* course. It is highly recommended, however, that they do take the course even though the principal focus of the material covered is research laser safety. Much of this material applies, as well, to medical and clinical lasers.

2. On-the-job/hands-on training:

This is to be conducted by the laser system vendor and persons well experienced in the safe operation of the specific medical/clinical lasers to be used. All persons who will be using the lasers must be provided with adequate on-the-job training so that they are sufficiently competent to operate them independently and safely, and to feel comfortable doing so. All appropriate operational procedures need to be covered in this training including needed safety equipment and other safety-related considerations.

√ All references to “EH&S” in the remainder of this document imply *main campus EH&S*.

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B. WARNING SIGNS AND ACCESS CONTROL

All rooms in which lasers are used in medical procedures must have permanent door-type warning signs, slider-type warning signs, or illuminated “Laser On”/“Laser Operating” warning signs posted. If sliders are used, they need to indicate that lasers are in use when they are and then be returned to the other position (laser no longer in use) once the procedures have ended. EH&S provides doorknob-type warning signs (“Do not enter, Laser operating inside”) on request for use temporarily in cases when persons intending to enter procedure rooms need to be prominently alerted regarding potentially enhanced hazards inside.

In cases in which illuminated warning signs are present outside procedure rooms, these signs should only be turned on during laser use. Otherwise, they become part of the landscape and are ignored.

Only physicians, nurses and technicians needed to perform the procedures are permitted inside laser use areas with the patient. All others, especially *casual visitors/family members and persons not trained in laser safety*, must be excluded. Ideally, the door to the laser procedure room should be locked during laser use.



C. MEDICAL LASER SAFETY PROCEDURES

Before the procedure

- ❖ Make sure that only persons who need to be there and who are sufficiently trained are present.
- ❖ Make sure any windows in the laser procedure room are covered and the laser use area is isolated from other areas of the rooms by screens or barriers.
- ❖ Make sure the illuminated warning sign is on (if present) or the slider is in the correct position, and that the door is locked.
- ❖ The person using the laser should remove all unnecessary reflective items from the area in which the beam will be located to avoid unwanted reflections/stray radiation. This includes shiny medical instruments, jewelry, watches, plastic ID card, etc.
- ❖ Ensure that there are sufficient pairs of protective eyewear available for physicians, nurses, technicians, and patients and that each pair is the correct type with regards to the laser wavelength to be used and the laser power. Contact EH&S at (949) 824-6098 with any questions concerning protective eyewear.
- ❖ Airborne contaminant control systems (local exhaust suction, etc.) must be operational.



During the procedure

- ❖ Everybody present who has a reasonable likelihood of being exposed to laser radiation must wear protective eyewear. Keep protective eyewear on during the entire process. This includes the patient being treated especially if the treatment area is near his/her face.
- ❖ ***The beam must be carefully controlled at all times.***
- ❖ Never leave a laser operating and unattended in an unsafe condition.
- ❖ Laser firing foot pedals and finger switches must be separate from any similar switches to avoid confusion.
- ❖ **Keep in mind that the most dangerous lasers are the invisible beam lasers, particularly near-infrared lasers.** Use a high degree of caution when operating these types of lasers.

After the procedure

- ❖ Keep protective eyewear on until the laser system is off or placed into a safe mode (standby).
- ❖ Remove the temporary alignment doorknob warning sign or move the slider to the laser-off position.
- ❖ Always store the protective eyewear near the lasers for which it is worn such that it will not get lost, scratched, or broken. Keep the eyewear in protective cases, if possible, in a clean and dry location.



D. PROTECTIVE EYEWEAR

Contact EH&S or the laser eyewear vendors for assistance in selecting eyewear including calculating the **optical density (OD)** needed for adequate laser radiation filtration. Complete the attached *Laser Safety Eyewear Evaluation* form and return it to EH&S for assistance in determining the needed OD.

The protective eyewear vendors below have good eyewear selections and excellent customer service. They supply all types of laser eye protection and they frequently give discounts on eyewear to educational institutions like UC Irvine:

NoIR Laser Company

P.O. Box 159, South Lyon, MI 48178
Phone: 800-521-9746 ; Fax: 734-769-1708
Web: www.noirlaser.com

Trinity Technologies

595 Phalen Blvd., St. Paul, MN 55101
Phone: 800-393-5565; Fax 651-357-1830
Web: <http://www.lasersafety.com/>

Glendale Eyewear Authorized Distributors

Mallory/ California Safety & Supply Co.

44340 Osgood Road, Fremont, CA 94539

Phone: 408-727-8530

Web: www.calsafety.com

Kentek Corporation

1 Elm Street, Pittsfield, NH 03263

Phone: 800-432-2323

Web: www.kenteklaserstore.com

Newport Corporation

1791 Deere Avenue, Irvine, CA 92606

Phone: 949-863-3144

Web: www.newport.com

* **Note: Special M-rated eyewear is needed for ultrafast lasers (pulse duration < 1 nanosecond).**



E. CONTROL OF NON-BEAM HAZARDS

1. Electrical hazards

Only persons experienced in electrical maintenance and repair may perform these tasks on medical lasers. EH&S offers a course in *High Voltage Safety*; interested persons can register at www.ted.uci.edu. High voltage power supplies should only be serviced when personnel knowledgeable in performing cardiopulmonary resuscitation (CPR) are present. The Anteater Recreation Center on campus offers CPR and First Aid classes (<http://www.campusrec.uci.edu/>).

2. Fire hazards

Class 4 visible and infrared beams with irradiances above 10 W/cm^2 can ignite combustible materials like paper, drapes, plastic endotracheal tubes, and clothing. Keep combustible materials including all organic solvents like rubbing alcohol and all flammable anesthetic gases away from laser use areas. A fire extinguisher must be present for use in the event of a fire. There have been reports of ignition *in vivo* of anesthetic gases and intestinal gas during laser procedures so caution must be exercised regarding that potential hazard.

3. Chemical hazards

Fluorine and chlorine gases are used with excimer lasers; these need to be stored in approved ventilated gas cabinets. Dye solutions used with pulsed dye lasers need to be mixed in a properly functioning fume hood by personnel wearing personal protective equipment; ideally, the vendor will provide dye mixtures. Material Safety Datasheets for toxic materials must be reviewed prior to using them: <http://www.ehs.uci.edu/msds.html>



4. Laser-generated air contaminants

These are potentially toxic substances generated when high power laser beams strike target materials such as plastic and tissue. Enhanced general dilution ventilation and local exhaust ventilation/suction are two means of controlling this hazard. In rare cases, respirators need to be worn. Keep in mind that surgical masks are not intended to be completely protective against smoke generated from laser beam/tissue interactions. A more substantial respirator is needed for that purpose especially since the plume emitted from tissue during laser surgery can contain pathogens (bacteria, viruses) in addition to other combustion products. *Local exhaust removal with a suction system is the best means of control.*

5. Collateral radiation

Some laser systems can generate x-rays, ultraviolet radiation, intense non-coherent visible radiation, or radiofrequency radiation. Contact EH&S if you have any concerns regarding this. Exposure of bone to laser radiation might result in a low level of collateral ultraviolet radiation.

6. Noise

Some lasers can emit loud noise during pulsing. Contact the Industrial Hygiene Division of EH&S at (949) 824-6200 for assistance with hearing protection and noise control methods.



F. EMERGENCY PROCEDURES

In the event that you or somebody else in your group suffers an eye or skin injury:

1. Turn off the laser involved in the accident immediately and unplug it. Post a “Do not use!” sign on the laser to ensure it is not used again until it can be determined that it is safe.
2. Keep the injured person calm. If an eye injury is suspected, keep the person in an upright position.
3. ***Make sure the injured person receives immediate medical treatment if the injury is serious – injured persons need to be seen by a doctor as soon as possible.***

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4. Arrange for transportation of a seriously injured person to a medical facility. The victim might be in shock or have impaired vision so self-transportation is contraindicated. See the attached *UC Irvine Injuries and Medical Treatment* poster for locations for emergency treatment.
5. If the injury is life-threatening (electrocution), **call 911 immediately**. Call the UC Irvine Police at (949) 824-5222. Perform CPR if you are trained to do so.
6. Minor skin injuries can often be treated by rendering First Aid in the laboratory.
7. Notify persons who need to be informed about the accident (Medical Director of facility, UCI Laser Safety Officer (*for main campus incidents only*), UCI Medical Center Radiation Safety Officer (*for incidents at UCIMC*), Nursing Supervisor, etc.).



G. MOST COMMON CAUSES OF MEDICAL/CLINICAL LASER ACCIDENTS

1. Poor control of laser beam; hand-held beam delivery wand not well managed.
2. Fatigue, rushing through procedure.
3. Laser operator not sufficiently trained.
4. Eye protection not worn or the wrong eyewear worn.
5. Laser procedure area not optically isolated from other nearby areas and entryways.
6. Manufacturer and laser user installed safety features removed or bypassed.
7. Laser system not properly maintained.
8. Inattention to potential electrical and fire hazards.
9. Hand accidentally placed in beam and burned.
10. Stray radiation off of reflective medical instruments.





H. SPECIFIC LASER SAFETY PROCEDURES

☞ Please add below any appropriate laser safety-related procedures specific to your medical or clinical laser applications that are not covered by the above general safety procedures. These should include any special laser system startup, alignment, and shutdown procedures including all safety-related and patient-related steps:



UC IRVINE MEDICAL LASER SAFETY CHECKLIST

- PHYSICIAN, TECHNICIANS, AND NURSES SUFFICIENTLY TRAINED**
- DOOR LOCKED AND WARNING SIGN POSTED/WARNING LIGHT ILLUMINATED**
- BEAM WELL CONTROLLED AND LASER USED BY PHYSICIAN ONLY**
- OTHER AREAS ISOLATED BY SCREENS OR BARRIERS; WINDOWS COVERED**
- LASER “POWER UP” WARNING LIGHTS CLEARLY VISIBLE**
- FOOT PEDAL OR FINGER SWITCH LABELED/GUARDED/WELL CONTROLLED SO NO ACCIDENTAL FIRING OF LASER**
- ONLY ANODIZED/BLACKENED/MATTE FINISH RETRACTORS IN BEAM AREA**
- UNNEEDED REFLECTIVE ITEMS REMOVED FROM BEAM AREA AND HANDS**
- PROTECTIVE EYEWEAR AVAILABLE AND USED BY EVERYBODY PRESENT**
- ALL NEEDED SUPPLIES READILY AVAILABLE**
- ALCOHOL AND WET IODINE PREPS DRY BEFORE FIRING LASER**
- ELECTRICAL, FIRE, COMPRESSED GAS, AND CHEMICAL HAZARDS PROPERLY CONTROLLED**
- CAUTION USED WHEN HANDLING SALINE OR OTHER CONDUCTIVE FLUIDS NEAR ELECTRICAL SYSTEMS**
- SYSTEMS TO REDUCE LASER GENERATED AIR CONTAMINANTS OPERATIONAL (LOCAL EXHAUST, ETC.)**
- PHYSICIAN/SURGEON TESTS LASER BEFORE USE TO CHECK SPOT SIZE, FLUENCE, ETC., POSSIBLY USING A TONGUE DEPRESSOR OR BEAM CARD/PAPER**

Checklist completed by _____

Date _____

Notes _____



LASER SAFETY EYEWEAR EVALUATION

Person Requesting Evaluation _____ Date _____

Principal Investigator/Physician _____

Department/Medical Facility _____

LASER DATA	Laser 1	Laser 2
<i>Type of Laser</i> (Nd:YAG, Argon, HeNe, etc.)		
<i>Class of Laser</i> (3b or 4)		
<i>Wavelength(s) Produced</i> (nm)		
<i>Operation:</i> Continuous Wave, Single Pulsed, Repetitively-pulsed, Q-Switched, Mode-locked (<i>more than one might apply</i>)		
<i>For Continuous Wave Laser:</i> Maximum Power (mW or W)		
<i>For Pulsed Laser:</i>		
Maximum Pulse Energy (μ J, mJ or J)		
Pulse Duration		
Pulse Repetition Frequency (Hz)		
<i>Maximum Exposure Duration*</i>		
<i>Optical Density (OD) Needed*</i>		

*** To be determined by EH&S**

Return to Rick Mannix, EH&S, Zot Code 2725
 [Or call (949) 824-6098 if you have any related questions]

UC IRVINE INJURIES & MEDICAL TREATMENT

 **CALL 911 IF THE CONDITION IS LIFE THREATENING OR REQUIRES IMMEDIATE MEDICAL ATTENTION** 

Notify your supervisor or faculty staff if condition is not life threatening. Seek medical attention as follows:

Graduate Students (non-UCI employees)

Campus: Gottschalk Medical Plaza, Primary Care Clinic on campus 824-8600. Hours: Mon-Fri 8-12 & 1-5

UCIMC: Call the UCIMC Referral Center 714-456-7001. Hours 8-5:30

Or contact Beth Laham with the GSHIP program (see below)

After hours: Call the UCIMC Referral Center 714-456-7890. Open 24 hours daily.

The Gottschalk Medical Plaza ([map](#)) is the primary care facility for students covered by the Graduate Student Health Insurance Plan (GSHIP). **Graduate students with private HMO health insurance instead of GSHIP will be directed to their plan's urgent care facilities. Private PPO insurance may be accepted.** Graduate students can be seen at Student Health Center by special referral and only with prior authorization from the GSHIP Coordinator.

For further information, contact Beth Laham with the GSHIP office at (949) 824-2388 or see the GSHIP web site <http://www.gship.uci.edu/>.

Undergraduate Students (non-UCI employees)

Campus: Student Health Center on campus 824-5304. Hours: Mon-Fri 7:30-5:30

After hours: Go to the nearest urgent care center or hospital emergency room.

Be sure to contact Student Health Center for follow-up care as soon as possible.

The Student Health Center ([map](#)) is the primary care facility for students covered by the Undergraduate Student Health Insurance Plan (USHIP). **Undergraduate students with private health insurance instead of USHIP will be charged for services provided at the Student Health Center and provided a receipt to obtain reimbursement.**

For further information, see the Student Health Services website www.shs.uci.edu.

Employees, all student employees, and volunteers with work-related injuries

Employees or their supervisor must contact UCI Worker's Compensation Desk at 949-824-7008 during regular working hours to obtain medical authorization within 24 hours of any injury.

ALL WORK RELATED INJURIES MUST BE REPORTED via the On-line Incident Form available at the Human Resources website at www.hr.uci.edu, and link to [Workers Compensation](#) or call (949) 824-7008

Newport Urgent Care (949) 752-6300

Located off campus ([map](#)) - 1000 Bristol Street North, Suite 1-B, Newport Beach
Mon-Fri 8am-8pm; Sat & Sun 9am-5pm; Call for after-hours physician.

Occupational Health Clinic at UCI Medical Center (714) 456-8300

Located on campus ([map](#)) - Pavilion III, Building 29
Mon-Fri 7am-9pm, Closed Sat & Sun; After hours - Go to UCIMC emergency room

Occupational Services at Long Beach Memorial Hospital (562) 933-0085

Mon.-Fri. 7am-9pm; Sat. 9am-5pm; Call for after-hours physician.



SOME COMMON LASERS USED IN MEDICAL APPLICATIONS

Target Organs ☞ **Parts of body that can be injured by inadvertent exposure to laser radiation**

Carbon Dioxide (CO₂) Laser

Far infrared beam – 10,600 nm

Target organs – cornea of eye, skin (thermal burns)

Generally continuous wave operation, sometimes pulsed

Can be focused to cut tissue, or defocused to ablate or shave tissue

☞ *Uses: Removal of skin lesions, as laser scalpel, surgery for snoring (rhinophyma), skin shaving/resurfacing, wrinkle removal, cutting/vaporizing tissue, endoscopic surgery, dental treatments*

Argon Laser

Blue-green visible light (488 nm, 514 nm)

Target organs – retina of eye, skin (thermal burns)

Continuous wave or pulsed

☞ *Uses: Retinal/ear surgery; port wine birthmark removal; spider vein removal, photodynamic therapy (shrink/dissolve tumors)*

YAG Lasers:

Nd:YAG

Near infrared beam (1064 nm or 1320 nm)

Target organs – retina of eye, skin (thermal burns)

Continuous wave or pulsed

☞ *Uses: Tattoo removal, hair removal*

KTP/YAG

Green visible light (532 nm)

Target organs – retina of eye, skin (thermal burns)

Continuous wave or pulsed

☞ *Uses: Removal of prominent veins, cuts tissue, red/orange tattoo removal, endoscopic surgery*

Erbium YAG

Middle infrared beam (2940 nm)

Target organs – Cornea of eye, skin (thermal burns)

Generally pulsed

☞ *Uses: Cosmetic laser resurfacing, remove superficial skin lesions; used in dentistry*

Holmium:YAG

Middle infrared beam (2070 nm)

Target organs – Cornea of eye, skin (thermal burns)

Generally pulsed

☞ *Uses: Ablate bone and cartilage, orthopedic, urological, ENT, dental applications*

Ruby Laser

Red visible beam (694 nm)

Target organs – retina of eye, skin (thermal burns)

Pulsed

☞ *Uses: Tattoo and pigmented lesion removal, hair removal*

Alexandrite Laser

Red visible beam (755 nm)

Target organs – retina of eye, skin (thermal burns)

Pulsed

☞ *Uses: Tattoo and hair removal*

Pulsed Dye Laser

Yellow visible beam (577 – 585 nm)

Target organs – retina of eye, skin (thermal burns)

Pulsed

☞ *Uses: Port wine stain and scar removal, and vascular lesion treatments (facial spider veins, Rosacea)*

Copper Vapor Laser

Green visible beam (511 nm, 577 nm)

Target organs – retina of eye, skin (thermal burns)

Pulsed

☞ *Uses: Vascular lesion treatments*

Diode Laser

Near-infrared beam (800 – 900 nm)

Target organs – retina of eye, skin (thermal burns)

Pulsed or continuous wave

☞ *Uses: Hair removal, periodontal surgery, superficial vein removal*

Excimer Laser

Ultraviolet beam (193 nm most common)

Target organs – cornea/lens of eye, skin (photochemical burn)

Pulsed

☞ *Uses: LASIK, PRK (eye surgeries)*



Intense Pulsed Light

Intense Pulsed Light (IPL) is currently being used as an alternative to coherent laser light to treat a variety of skin conditions including tattoos and spider/leg veins as well as for hair removal. Basically the IPL device is an intense flashlamp attached to a power source. Pulses of broadband light are applied through colored filters which can be adjusted to match the patient's skin type and the targeted lesion. The cost of the devices and of IPL procedures are similar to those of comparable lasers and clinical laser procedures. ***Although fast and versatile, IPL devices are as a rule somewhat less effective for a given task than a laser dedicated to the purpose.*** Protective eyewear needs to be worn during IPL treatments such as these types below.

http://www.rli.com/products/eyewearitemdetail.asp?Heading=Laser_Eyewear&item=E-G-9624

http://www.lasernet.com/safety_eyewear_ipl.htm

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☞ **Contact Rick Mannix, Laser Safety Officer of UC Irvine Main Campus, regarding any questions concerning the contents of this document.**