Guidelines for the Safe Use of Lasers by Members of the College of Chiropodists of Ontario

COLLEGE OF CHIROPODISTS OF ONTARIO TECHNICAL COMMITTEE

Martin Hayles (Chair), Edward Chung, John Lanthier, Sasha Kozera,

Tony Merendino, Tracy Oliver

PURPOSE:

The Registrar of the College of Chiropodists of Ontario(COCOO) referred the following task to the Technical Committee of the College of Chiropodists, to respond to a request from the Executive committee

The Executive request the drafting of guidelines on the safe use of lasers to be used by Members of COCOO.

(The Committee deem the guidelines to be related to 'ALL' members of the College of Chiropodists of Ontario, including BOTH the Chiropodist and Podiatrist class of registrant.)

CORE POINTS IDENTIFIED, AND CONSIDERED BY THE TECHNICAL COMMITTEE:

- Definitions
- Power /Classifications
- Training
- Delegation
- Laser Safety Officer
- Hazard Evaluation/Environment/Personal Protective Equipment (PPE)
- Disinfection/Cleaning/Maintenance

METHODOLOGY

A literature review and detailed assessment of the available body of research that addressed the core points was performed using Medline, Google Scholar, Cochrane Database of Systematic Reviews, National Center for Biotechnology Information, and web based search engines. Data was distributed to committee members for analysis and reviewed during a teleconference.

FOREWORD

The use of lasers by Members is expanding, as the use of medical lasers has greatly enhanced and expanded treatment modalities, but with it comes a risk of harm to the patient, staff, and members. Patient and staff safety is of paramount importance. The purpose of this document is to ensure that Members stay current and informed of the best practices, follow proper protocols and procedures, and ensure the safety of their patients. Safety issues for the use of lasers are almost identical independent of which field in which they are used. Education regarding their safe use is essential for lasers to be integrated into a practice. A brief inadvertent exposure to high-power laser radiation can cause permanent eye injury and/or skin burns. This guideline is designed to give the Members essential information for laser safety. Following the guidelines listed in this document does not relieve the Member, from their obligation to take any additional measures necessary to prevent health hazards from occurring in the facility where they practice. Members remain responsible to COCOO for the management and practice at a facility. The Member and operator(s) should refer to the user information supplied by the manufacturer or distributor of their equipment, as well as their training resource materials, and related guidance documents. As technologies progress, it is anticipated that COCOO's laser-related guidelines will undergo review and expand to address these new advances.

This resource has been prepared to help Members understand some of their obligations under the Occupational Health and Safety Act (OHSA) and regulations. It is not legal advice. It is not intended to replace the OHSA or the regulations.

What is a Laser?

The term "laser" is an acronym that stands for "Light Amplification by Stimulated Emission of Radiation". Laser light is a form of non-ionizing radiation. Laser equipment produces and amplifies light that has unique properties that cannot be produced any other way. The light that it produces is monochromatic - it is composed of one single colour at a specific wavelength. Laser radiation can be generated in different parts of the spectrum - ultraviolet (UV), visible light, and infrared (IR).

The colour of laser light is usually described in terms of the wavelength of the laser radiation. The most common unit used for the wavelength of laser is a nanometer (nm - one billionth of a meter). Light from other sources is made up of combination of colours at various wavelengths.

Another property of lasers is they are coherent light sources. This means that lasers produce monochromatic light (i.e., with a single or selected wavelength) in which the light "particles" or photons all travel in the same direction. This allows laser beams to be very focused (collimated) so they do not fan out like the light beam of a flashlight. Since the light beam can be contained in a very narrow beam, it has a high radiant power per unit area. These properties enable laser devices to produce powerful laser beams that can even cut metal. Lasers are also used in medicine for cutting, sealing? Use cauterizing?, and surgical procedures.

Examples of Lasers Used by Members

Members use a wide variety of lasers. The type of laser depends on the purpose of use. They can be used to smooth skin wrinkles or remove warts, skin moles, cysts, tattoos, spider veins, and so forth. Some commonly used lasers are given in *Appendix F*.

Standards Used to Regulate Lasers

Members should be aware that use of these lasers is subject to provincial legislation, for purposes of worker health and safety. COCOO will not directly enforce other agencies' legislation; however, COCOO has a role to monitor evidence of member's compliance with facility requirements under other legislation. One such requirement is to ensure that laser devices meet certain standards. These obligations arise under the Occupational Health and Safety Act (OHSA). These are worker safety provisions. COCOO will monitor through the practice inspection process whether members have had their lasers maintained, the facility has proper standards for use, and procedures are in-place for all workers to comply with Occupational Health and Safety regulations under OHSA

Canada's federal government controls the sale, lease and import of lasers, as per the Radiation Emitting Devices Act http://laws.justice.gc.ca/en/R-1, and lasers must meet the requirements of the Act. Members are advised that they should only purchase laser devices that have an active Canadian medical device license in accordance with the Medical Devices Regulations. Canada has not yet adopted a specific laser hazard classification system. However, manufacturers who wish to

sell, import or lease laser systems in Canada have been referred to the labelling requirements outlined in Europe and the US. While compliance with the requirements as stated in this document is voluntary, there are regulatory requirements governing the use of lasers in each province and territory

In the Province of Ontario, the general duty clause 25(2) (h) of the Occupational Health and Safety Act (OHSA), requires employers to take every precaution reasonable in the circumstances for the protection of a worker. This includes the protection of workers from the hazards associated with lasers. When enforcing the general duty clause under OHSA, the Ontario Ministry of Labour's Radiation Protection Service takes into consideration.

- The CSA Standard CAN/CSA-Z386-14: *Safe Use of Lasers in Health Care*
- The American National Standards Institute (ANSI) Standard Z136.3-2011: *Safe Use of Lasers in Health Care* and Z136.1-2014: *Safe Use of Lasers*
- IEC 60825-1 Ed. 2.0 (2007) " Safety of laser products - Part 1: Equipment classification and requirements".
- FDA 21CFR1040.10 (2007) "Performance Standards for laser products" and "Laser Notice No. 50".

LASER CLASSIFICATIONS

Class 1

Laser equipment emitting radiation that is not considered hazardous even with long-term exposure, and do not require hazard-warning labelling. Examples include positioning and alignment lasers, low-level laser therapy and home-use lasers.

Class 1M

Laser equipment emitting radiation that is not considered hazardous for the naked eye even with long-term exposure.

Class 2

Laser equipment emitting visible radiation in the wavelength range from 400 nm to 700 nm that is considered safe for exposures of duration less than 0.25 seconds. Examples include alignment lasers used in aiming invisible radiation of CO2 and Nd:YAG lasers.

Class 2M

Laser equipment emitting visible radiation in the wavelength range from 400 nm to 700 nm that is considered safe for the naked eye for exposures of duration less than 0.25 seconds.

Class 3R

Laser equipment emitting radiation that can exceed the Maximum Permissible Exposure (MPE) when viewed directly but with low risk of permanent eye injury.

Class 3B

Laser equipment emitting radiation that is considered hazardous to the skin and eyes from direct exposure or a specular reflection.

Class 4

Laser equipment emitting radiation that is considered hazardous to the skin and eyes from direct exposure or a specular or diffuse reflection.

TYPES OF HAZARDS FOUND WHEN USING LASERS

Sources of laser hazards include:

- Accidental eye exposure during alignment
- Misaligned laser beam
- Lack of eye protection
- Equipment malfunction
- Improper handling of high voltage systems
- Use of unfamiliar equipment
- Improper restoration of equipment following service

There are two types of laser hazards: the laser beam hazards and the non-beam hazards.

- Laser beam hazards include eye and skin burns which are due to laser beam exposure on a person's body.
- Non-beam hazards are associated with the laser equipment or the hazardous substances released from the laser equipment, and fumes

emitted from materials exposed to laser beams, including laser-plumes produced during surgical procedures.

The maximum permissible exposure (MPE) limits: the level of laser radiation to which an unprotected person may be exposed without adverse biological changes in the eye or skin i.e. injury for various medical surgical lasers are demonstrated in *Appendix G.*

TRAINING AND QUALIFICATIONS

It is inappropriate and inconsistent with the generally accepted standards of practice for a Member to administer or perform a treatment or perform any function, which is beyond the parameters for the Member education, capabilities, and experience. The level of training is in proportion with the degree of potential laser hazards. Health Canada advises those using or working near Class 3B or 4 lasers must have laser safety training with the following topics covered:

- Fundamentals of laser operation
- Overall responsibility for laser safety
- Laser classification
- Potential laser hazards associated with operating a laser, including the significance of reflections
- Control measures
- Cleaning and maintenance of protective equipment
- Medical surveillance
- Patient care (pre- and post-treatment)
- Emergency procedures (i.e. how to use fire equipment, resuscitative procedures, etc.)

(Laser Hair Removal Safety Guidelines for Facility Owners & Operators Prepared by The Joint Documents Working Group of The Federal Provincial Territorial Radiation Protection Committee First Edition October 2011)

It is important to understand that frequently tissue is altered or destroyed by a laser without pathologic confirmation. Because of this, it is imperative that the

Member has the clinical expertise in the assessment of cutaneous lesions with a level of proficiency that meet the minimal specific level required by COCOO. Before using a laser, a Member must obtain appropriate training for the laser's use and the conditions under which the laser is to be employed. Proof of training should be readily available to COCOO for the purposes of an assessment, inspection, or request.

Recommendations for Training

It is recommended that training should include:

• Basic Laser Physics: Definitions and explanations of laser terminology, electromagnetic energy, wavelength, laser systems, types of lasers, beam characteristics, and tissue responses.

• Laser Energy Delivery Systems: The components of laser energy delivery systems (fiber optics, sheathed fibers, hand pieces etc.).

• Clinical Applications: In-service training should be geared towards specific lasers in the clinic as well as the specific indications for laser treatment.

• Safety: Should cover regulatory agencies or standards such as ORNAC (Operating Room Nurses Association of Canada), classification of lasers, procedure safety and equipment checks, major hazards associated with lasers in a clinic, eye protection, window coverings, warning signs and systems, electrical / water safety, fire prevention, emergency laser shutdowns, safety with gases, smoke evacuation, and laser safety publications.

• Policies and Procedures: Set of policies and procedures should be documented in the clinic to include but not limited to; laser policies and standards in general, personnel training, safety, equipment operation and maintenance, responsibility of staff members and current laser resource information.

•Continuing Education: Continuing education should be made available as necessary (to include outside training sessions) with reasonable frequency to help ensure adequate performance, especially when new lasers are introduced into the clinic. Organizations such as the American Society of Laser Medicine and Surgery (ASLMS) provide ongoing educational opportunities and publications in

clinical laser medicine and surgery. *(https://www.aslms.org/for-professionals/education-center)*

The College of Physicians and Surgeons of British Colombia recommend a layered system of education and training framework of laser personnel.

Level 1 Laser Training

This is necessary for:

- non-clinical facility personnel who are involved in the management of the laser program or laser services
- observers
- trainees

The content includes, but is not limited to:

- overview of CSA Z386 Safe use of lasers in health care
- facility policy and procedure
- types of lasers used and general applications in the facility
- roles, authority, and responsibilities of laser team members
- contact information for the LSO

Level 2 Laser Training

This is necessary for:

- laser operator (assistant)

The content includes, but is not limited to:

Level 1 Last training

- laser physics
- laser-tissue interaction
- types of lasers and their delivery systems
- accessory equipment and instrumentation needed for specific applications
- understanding treatment parameters and dosimetry
- roles, authority, and responsibilities of laser team members

- assessment of hazards and risks
- reporting
- applicable documentation

Level 3 Laser Training

This is necessary for:

- laser safety officer (LSO)

The content includes, but is not limited to:

- all items in Level 1 and 2 training
- regulatory requirements in the specific authority
- application of CSA Z386 Safe use of lasers in health care
- hazard identification and implementation of applicable control measures
- facility reporting for accidents, incidents, or occurrences

Level 4 Laser Training

This is necessary for:

- laser users (Member)
- The content includes, but is not limited to:
- all items in Level 1 and 2 training
- clinical application and techniques for intended procedures
- treatment parameters and dosimetry for intended procedures
- patient safety
- management of complications
- competency in operating the laser and its delivery systems
- competency in use of safety equipment (e.g. protective eyewear, emergency stop switch, standby switch, plume evacuator, accessory instrumentation, fire extinguisher, wet drapes, etc.)

Assistant Training

Training programs for assistants should consist of a laser course that is in accordance with applicable standards, the facility's policies and procedures and

federal and local regulations. Programs should include hands-on practical application and a written test.

College of Physicians and Surgeons of Ontario (CPSO) suggest that entry qualifications for RNs working in a cutaneous laser unit should be: '*Current certification of registration from the College of Nurses of Ontario, Minimum of two (2) years nursing experience, Current certification in Basic Cardiopulmonary Life Support (BCLS) Experience in cutaneous laser surgery is preferred but not mandatory BScN is preferred but not mandatory'*

DELEGATION AND RESPONSIBILITIES OF THE MEMBER

The Member is responsible and accountable for all clinical functions for all patients assigned to their care. The Member must always consider the patient's risk factors. Their presenting clinical status should be assessed prior to laser use. The Member should be knowledgeable about expected outcomes, resulting from administering the specific laser treatment to the patient

It is recommended that only a Member should apply laser for cutting tissue. This task should **not** be delegated. Only a Member, should apply laser for destroying tissue however, delegation to a Registered Nurse (RN or Nurse Practitioner (NP) may be acceptable. Members may delegate the use of a therapeutic (cold) laser to someone who is suitably trained /educated.

This is consistent with other regulatory bodies in Canada. (The College of Podiatric Surgeons of British Columbia: Practice Standards and Guidelines, CPSO, CPSBC (British Columbia))

All assistants (foot care assistants, registered nurses (RN)), need to possess the necessary skills and knowledge to use lasers for patient treatment in any office*. (It is a RN responsibility to ensure they have knowledge of their scope of practice and the requirements of the facility and College of Nurses of Ontario)*.

The Member is responsible for ensuring the safety of the patient and all personnel in the laser-controlled area during laser set-up and duration of use.

When using a laser to cut or destroy tissue the Member should:

- remain in the laser room always during laser usage
- ensure the environmental and procedural control measures are in place (e.g. protective eyewear, plume evacuators)
- ensure clear communication with the laser operator (assistant)
- handle the laser delivery device and be the only one operating the laser footswitch or hand-held device
- select the appropriate laser parameters for the procedure,
- activate, fires and/or deploys the laser
- report any unusual events and safety concerns to the LSO

The assistant should act on the Members orders only after the patient has been assessed and evaluated by the Member. The assistant should only implement the selected laser treatment when the Member is physically available to the practice setting. Members orders should include: type of selected laser, the fluence of the laser beam, laser beam (spot size), wavelength, pulse width, description, location, and size of the area to be treated, and utilization of any topical anesthetic agent such as ice.

Written policies and procedures within the office setting shall guide the Member for each specific laser type/treatment administered. The written policies and procedures should include equipment and operator safety, patient education, patient assessment, emergency procedures, and monitoring guidelines.

The assistant administration of laser treatment shall be a component of a written process for continuous quality monitoring of expected patient outcomes.

The Member should have an educational and credentialing mechanism, which includes a process for educating and verifying the assistant's education; training and clinical competency to perform specifically identified selective laser treatments.

The assistant is also required to have knowledge of laser equipment and techniques, necessary skills to perform patient assessment, knowledge of monitoring and evaluating the patient during the treatment, able to provide

patient education specific to the selected laser treatment, and the ability to maintain both patient and operator safety while utilizing the laser equipment.

LASER SAFETY OFFICER (LSO)

In Ontario, the general duty clause 25(2) (h) of the Occupational Health and Safety Act (OHSA), requires employers to take every precaution reasonable in the circumstances for the protection of a worker. This includes the protection of workers from the hazards associated with lasers.

When enforcing the general duty clause under OHSA, the Ontario Ministry of Labour's Radiation Protection Service considers various standards relating to lasers. The CSA Standard Z386-14 "*Safe Use of Lasers in Health Care*" specifies that facilities using lasers shall have a laser safety officer (LSO) and a laser safety committee (LSC) to perform risk assessments, and to ensure that laser safety policies and procedures are developed, implemented, and maintained. The American National Standards Institute (ANSI) Standards Z136.1 "*Safe Use of Lasers*" and Z136.3 "*Safe Use of Lasers in Health Care*" also have requirements for LSOs and LSCs. The Canadian Centre of Occupational Health and Safety (CCOHS) has the OSH Answers document on Lasers - Health Care Facilities and has additional information on laser safety programs, and LSOs .

Besides creating a safe environment for patients and employees, there are other reasons why Members should place an emphasis on proper laser safety. First, is laser safety compliance with the Ontario Ministry of Labour. The Ontario Ministry of Labour now requires that if you have a Class 3B or Class 4 laser on your premises, all users and operators require laser safety training, and that a Laser Safety Officer (LSO) be appointed. Failure to comply with the Ministry of Labour, under the Occupational Health & Safety Act is considered a punishable offense. *Occupational Health and Safety Act Part IX, Sec 66 – Offenses and Penalties*.

The Member or any member of the clinical team may be designated as the LSO. The ideal person for enforcement as the LSO is the Quality Advisor/ Clinical

Director. The daily responsibility of implementation and for monitoring the laser safety program may be best delegated to an Associate LSO.

An LSO does **not** assume clinical responsibility for monitoring treatment protocols or for advising Members on the correct clinical use of laser equipment. There is a distinct difference between hazards related to laser safety and those related to patient treatment.

The LSO must develop a laser safety program that meets the general requirements of the ANSI Z136 series of laser safety standards and specific precautions relating to the use of each laser system. Mandating compliance among staff, visitors, and patients. Delegating responsibility for implementation and monitoring compliance to the Associate LSO. Final enforcement within the framework of provincial and national regulations and international standards.

Duties of a Laser Safety Officer

- Confirm classification of laser.
- Read manufacturers' instructions for installation and maintenance of the laser equipment.
- Make sure that laser equipment is properly installed.
- Train workers in safe use of lasers.
- Limit access to laser areas.
- Maintain laser equipment properly.
- Post appropriate warning signs.
- Recommend appropriate personal protective equipment such as eye wear and protective clothing

LSO training and resources are available at the following locations:

https://canadianlasersafety.com/courses/medical-laser-safety-officer-training/

https://canadianlasersafety.com/courses/aesthetic-laser-safety-officer/

https://www.lia.org/store/course/LSOONLINE

LASER SAFETY PROGRAM

Any Laser Safety Program must be designed per existing national and professional standards.

The program must be comprehensive and must include beam and non-beam hazard prevention and control, audit and recording provisions, education and training of operational and support staff, and emergency fire procedures.

That hazard controls must include administrative, engineering or technical, and procedural components.

Successful prevention of exposure to laser hazards and injury to patients or personnel is best achieved with general measures being complemented with a mindset of "*safety first*" among all personnel, which is communicated to patients and visitors.

General measures, such as controlled access to laser treatment areas, use of specific signs and eyewear must end with each Member performing a procedure adopting the role of a "field LSO", and stringently observes the precautions for that specific wavelength and laser.

The ANSI Standard Z136.1 recommends a laser safety program for workplaces using class 3B or class 4 lasers. Following are the essential components of a laser safety program:

Administrative

- A written Laser Safety Policy.
- Posting of warning signs.
- Designation of the authority and responsibility for the evaluation and control of laser hazards to a Laser Safety Officer.
- Management of incidents (near accidents) and accidents including reporting, investigation, analysis, and remedial action.

- Training and education of personnel involved in the use and maintenance of lasers.
- Formation of Laser Safety Committee.
- Establishment of a Quality Assurance Program including regular inspection of the laser equipment.
- Presence of another person (buddy system) during maintenance work to provide first aid and to call for assistance in case of an injury or accident.
- Replacement and periodic eye examinations (consult ANSI Standard Z136.3).

Engineering Controls

- Local exhaust ventilation.
- Fail safe methods (e.g., automatic shutters to protect the user's eyes from reflected laser beam).
- Lock and key to prevent unauthorized activation of laser.
- Elimination of reflective surfaces from the room.
- Window covers (if necessary) to absorb scattered laser beam.
- Built-in access panel interlocks and automatic shutting to protect maintenance personnel.
- Safety latches or interlocks to prevent unauthorized access to controlled laser area.

Personal Protection

- Appropriate eye protection.
- Adequate respirators.
- Protective clothing and gloves.
- Personal protection program including training in the maintenance and use of personal protective equipment.

HAZARD EVALUATION

Hazard evaluation is a critical component of any laser safety program, as it influences the application of control measures. The following aspects of a laser's application influence the total hazard evaluation:

- The laser's capability of injuring personnel (i.e. laser classification).
- The environment in which the laser is used.

The first step in a hazard evaluation is to determine the laser classification. The LSO can normally rely on manufacturer information and need not perform any measurements. The "class number" can be read from the laser classification warning sign (i.e. 3B or 4). The LSO can then comply with all requirements of that laser class, including training

Then the LSO must consider the probability that unprotected personnel will be exposed to hazardous laser radiation (including operators, clients, service personnel, staff, and visitors). If exposure to the direct or specularly reflected beam is possible, the LSO must specify a laser controlled area and take appropriate actions to reduce the risk of overexposure.

Lastly, the LSO must determine whether the laser could initiate a fire in an appropriate combustible material. Laser beams represent a potential fire hazard if flammable or combustible materials are exposed to irradiances exceeding 10 W/cm² or beam powers exceeding 0.5 W. Since hair removal lasers are pulsed lasers, they usually provide beam energy information in Joules (J) per laser pulse, along with the length of time of the pulse. To use this information to determine whether a laser could pose a fire hazard, simply convert the Joules per second of one pulse into watts (W) using the conversion 1 J/s = 1 W. Then compare this number to 10 W/cm². Example: if a laser delivers 2J in 100ms to a 1cm² area, it is equivalent to 2/0.1 J/s per cm² or 20 W/cm². As this could initiate a fire in an appropriate combustible material, the LSO must apply certain fire control measures.

LASER TREATMENT CONTROLLED AREAS, WARNING SIGNS, & ENGINEERING CONTROLS

To ensure that individuals are not exposed to direct, reflected or scattered laser radiation without appropriate protection, it is necessary to: create a "laser treatment controlled area" within the facility install adequate engineering

controls; and post appropriate warning signs. A laser treatment controlled area is simply an area that is appropriately enclosed so that laser radiation which is above the maximum permissible exposure (MPE) does not inadvertently escape the treatment area to injure unsuspecting persons.

A Class 3B Laser Controlled Area:

A Class 3B Laser controlled area must:

- be under the direct control of authorized laser personnel trained in laser safety and laser operation
- be located so that access to the area by spectators is limited and requires approval by the LSO
- have only diffusely reflecting materials in or near the beam path (i.e. reflective items such as mirrors or jewellery must be removed or covered)
- provide personnel and patients with appropriate eye protection
- have high background illumination
- have all accessible windows, doorways, etc. covered
- laser warning signs are placed at all entrances to the laser room and removed when the laser procedure is completed
- doors to the laser room remain closed while laser is in use
- reflective surfaces that could interfere with the beam path are minimized (e.g. jewelry, mirrors, highly polished glass)
- have room walls that are rough in texture, dark and non-reflecting;
- have limited amounts of flammable compounds or substances
- provide adequate ventilation, respirators, fire fighting equipment, etc. to control all laser hazards
- have audible and visible activation warning systems to indicate that the laser is in operation or being tested
- have a master switch to control patient exposure
- require secure storage (e.g. access by computer code) or disabling (e.g. removal of a key) of the laser when not in use to prevent unauthorized operation. Laser keys must be kept in a secured location and;
- have an appropriate laser warning sign posted at the entry way to the laser controlled area (see example below)

Class 4 Laser Controlled Area

A Class 4 laser controlled area must:

- meet all the requirements of a Class 3B laser controlled area and;
- have a clearly marked "Stop" button for deactivating the laser or reducing output levels in the event of an emergency
- have area/entry safety controls designed to allow both rapid egress and admittance to the laser controlled area under emergency conditions
- Use a door, blocking barrier, screen, or curtains to attenuate laser radiation in the entryway
- have an appropriate laser warning sign posted at the entry way to the laser controlled area (see example below)

Laser Warning Signs

Sign dimensions, letter size and color, etc. must be in accordance with American National Standard Specification for Accident Prevention Signs, ANSI Z535 series.

For Class 3B or 4 lasers, the following is required: The signal word "DANGER". Instructions or protective action*.

1) For Class 3B lasers, use "LASER RADIATION - AVOID DIRECT EXPOSURE TO BEAM".

2) For Class 4 lasers, use "INVISIBLE LASER RADIATION - AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION" A symbol unique to lasers (use either the ANSI Z535 design or IEC 60825-1 design): The type of laser OR emitted wavelength, pulse duration (if appropriate) and maximum output. The laser classification number

* Other additional wording that can be used when appropriate: "Laser Protective Eyewear Required", "Invisible Laser Radiation", "Knock Before Entering", "Restricted Area", and "Do Not Enter When Light is On".

Appendix H has examples of laser safety signage.

Free downloads of signage are available at
https://www.lasertraining.org/DangerSigns.html

Beam Hazards

Protective Equipment

It is extremely important that all authorized personnel entering the laser treatment controlled area be provided with protective eyewear. Fire safety equipment and appropriate ventilation must also be available to protect the operator and patient from other potential laser hazards. Protective equipment must be serviced and maintained as recommended by the manufacturer to ensure safeguards remain functional.

Eyewear

Eye hazards when using lasers

The eye is the most vulnerable to injury from laser beam. The potential for injury depends on the power and wave length of the laser beam (light). Intense bright visible light makes us blink as a reflex reaction. This closing of the eye provides some degree of protection. However, visible laser light can be so intense that it can do damage faster than a blink of an eye. The invisible, infrared laser beam such as carbon dioxide (CO_2) laser beam does not produce a bright light that would cause the blinking reflex or the pupil to constrict and, therefore, chances of injury are greater compared to visible light beam of equal intensity.

The location of the damage depends on the optical nature of the laser beam. Lasers in the visible light and near infrared range focus on retina. Therefore, the injuries produced are retinal burns. The infrared radiation is absorbed in the cornea and may cause corneal damage and loss of vision.

Eye protection

Eyewear is the single most important piece of protective equipment needed by persons within the laser treatment controlled area. Studies have shown that 70 %

of laser eye accidents resulted simply because available protective eyewear was not worn, or inappropriate/damaged eyewear was worn.

Every piece of laser equipment has built-in engineering controls such as protective housing, fail-safe interlocks, master switches, beam stops and attenuators (e.g., light absorbers) to prevent accidental exposure. However, eye protection is needed while using Class 3B or Class 4 type lasers to prevent harmful exposure from reflected and scattered laser beams.

Protective eyewear for both the operator and the patient needs to be able to stop laser radiation coming from all directions from striking the eye

The ability of eyewear to filter the laser beam is expressed in terms of optical density. Optical density, type of laser, and visibility required are all important factors in the selection of protective eyewear. Protective eyewear may not provide the same degree of protection for infrared as for visible light and ultraviolet laser beams. Goggles with side shields are preferred because they provide protection against back reflection and side entrance of stray laser beams.

Selection of Protective Eyewear

Consult appropriate standards such as CSA Standard Z94.3.1-09 or American National Standards Institute (ANSI) Standard Z87.1 for guidance on selecting protective eye wear for your specific application.

Plastic versus glass lenses: Protective eyeglasses typically are available with plastic lenses. Plastic lenses are light weight and can be molded into comfortable shapes. However, care is needed because they can be affected by heat, and/or UV radiation which can darken the lens or decrease its ability to absorb laser energy.

Alignment eyewear: This type of eye wear is used for low power visible laser beams. Alignment eyewear should not be worn during the operation of high power or invisible laser beams. Instead, safety eyewear that provides adequate protection should be worn.

Eyewear will NOT provide protection for lasers that emit radiation of a different wavelength from that which the eyewear is designed for. Simple safety goggles or glasses must NEVER be used for laser eye protection. Protective eyewear must be labelled with the same wavelength that is emitted by the laser (i.e. 755 nm, 810 nm, 1064 nm, etc. The second important factor to look for in a pair of laser protective eyewear is the optical density (OD) number recommended by the

manufacturer. For MOST lasers used by Members, the OD number for the eyewear is usually 5 or greater.

Eyewear Do's and Don'ts

- Do choose eyewear recommended by the manufacturer that is suitable for the wavelength that you are using and the required OD. If the equipment is an intense pulsed light (IPL) system, use protective eyewear appropriate for multi-wavelength emissions.
- Do choose eyewear that fits snugly around the face, thus protecting against laser radiation from all directions.
- Do put protective eyewear on BEFORE the laser is operated.
- Do provide protective eyewear for everyone in the room, including the patient.
- Do provide an extra pair of protective eyewear located just outside the entry door for use in circumstances where a person may need to enter the room urgently or in an emergency.
- Do follow the manufacturer's recommendations on shelf life, storage conditions and appropriate cleaning methods.
- Do inspect protective eyewear regularly.
- Do keep laser eyewear in an opaque case when it is not in use, as the coating can be degraded by exposure to daylight over time
- Don't use eyewear that is cracked or loose, as light can pass through tiny gaps.
- Don't wear eyewear which is not designed for laser safety.
- Don't look into the primary beam or its specular reflection even when wearing goggles.
- Don't use abrasive or harsh chemicals to clean eyewear or anything other than hat is recommended by the manufacturer.

Remember! Nothing can be done to repair or reverse a laser retinal injury! Wearing laser protective eyewear is much less of a discomfort than experiencing eye damage!

Skin hazards and Protective Clothing

The potential for skin damage depends on the type of laser, power of the laser beam, and the duration of exposure. The type of damage may range from localized reddening to charring and deep incision.

Protective clothing gown, cap, mask, gloves, and safety eyewear may be required for working near a laser. Consult manufacturer's operating procedures and check with the laser safety officer to determine the specific needs for personal protective equipment and clothing.

Non-Beam Hazards

Fire Safety

Sources of Fire Hazards from Lasers

A fire can be started when the laser beam or reflection of the beam strikes a combustible material such as rubber, plastic, human tissues, paper products, skin treated with acetone and alcohol-based preparations, human hair, and intestinal gases. Fire hazards are of concern in oxygen-rich atmospheres when oxygen or when nitrous oxide is being used.

Preventative Measures for the Fire Hazard

- Train personnel to develop awareness about fire hazards and response procedures in case of laser fires.
- Make sure that hot tip of the laser does not touch combustible items.
- Maintain precise control of laser beam.
- Eliminate surfaces which can reflect laser beam.
- During surgery, the laser beam should be in the stand-by position always except when the hand-piece is in the hand of the surgeon.

- Make sure that skin preparation solutions are fully vaporised before covering the area with surgical drapes.
- Follow standard procedures in the event of fire or explosion

Dealing with combustible material requires that a laser operator anticipate accidental and/or unintentional laser exposures to materials and items located within the area in which they are working. Patient towels may be kept damp to reduce flammability. It may be necessary to have flammable or combustible materials near the laser emission area. For fires occurring near or on a patient/client, a container or bucket of water nearby may be preferred to a portable fire extinguisher. Either of these could be kept in the treatment room, while having access to a fire extinguisher near the room(s) housing the laser(s). If required barriers, curtains, and screens in the laser treatment controlled area should be made of flame retardant materials.

Electrical hazards

Many lasers use high voltage and high current electrical power. The danger of electrical shock or electrocution arises when an untrained or unauthorized person tries to perform maintenance work without following the proper safety procedures. The American National Standards Institute (ANSI) Standard Z136.3 outlines electrical safety procedures applicable to laser equipment. Electrical safety requirements include the following:

- Use proper grounding for metal parts of the laser equipment.
- Label laser equipment with electrical rating, frequency, and watts.
- Prevent explosions in high pressure arc lamps and filament lamps.
- Avoid contact with electrical components, including capacitors which can contain an electrical charge even after the power is turned off.
- Ensure that combustible components of electrical circuit are short circuit tested.
- Make sure that there is no electromagnetic interference between the laser equipment and other electrical equipment.

LASER PLUMES

To avoid the inhalation of airborne contaminants generated by high powered lasers, appropriate air evacuation systems must be used. The system required is determined by the laser beam power (i.e. irradiance, in W/cm²):

For a laser emitting less than 1 kW/cm², there is the potential for slight odours. Adequate building ventilation may be satisfactory.

For 1 - 10,000 kW/cm² powered lasers, air contaminants and laser smoke are associated with noxious odours. Required precautions may include local exhaust ventilation, respiratory protection, personal protective equipment, preventative maintenance, and training/education.

Airborne contaminants may include gaseous toxic compounds, bio-aerosols, dead and live cellular material, and viruses which need to be captured as near as practical to the point of production (e.g. within 2-5 cm of treatment area) and either completely trapped or vented out of the area in an environmentally sound manner. Filters and absorbers used in portable smoke evacuators require replacing on a regular basis. Always use safe work procedures when replacing filters and absorbers as they may be a biohazard.

Also, adequate and effective means to prevent the spread of infection shall be taken utilizing standard precautions for cleaning and disinfection of equipment.

What is a Laser Plume?

Lasers are used for surgery to vaporize, coagulate, and cut tissue. The vapours, smoke, and particulate debris produced during these surgical procedures are called laser plumes.

Content of a Plume

Laser plume may contain carcinogens, mutagens, irritants, and fine dusts. Plumes may also contain bioaerosols, viruses, blood fragments, and bacteria depending on the type of the procedure. They also contain carbon monoxide, polyaromatic hydrocarbons, and various toxic gases and vapours. Plumes may contain chemicals such as formaldehyde, hydrogen cyanide, acrolein, and benzene (*Appendix C*).

Health Hazards Associated with Laser Plumes

Members, staff, and patients can be at risk from exposure to laser plumes.

Health symptoms resulting from laser plume exposure include eye, nose, and throat irritation. At present, there is no further evidence of other short-term or potential long-term (chronic) health effects from long-term exposure to laser plume. Researchers state that more studies are required. However, carcinogens, mutagens and irritants have been found in laser plumes. The human papilloma virus (HPV) DNA and the human immunodeficiency virus (HIV) has also been found in the plume (*Appendix C*).

Controlling Laser Plumes

Contaminants generated by lasers can be controlled by:

- Ventilation
- Safe work practices
- Personal protective equipment

Ventilation

General room ventilation (dilution ventilation) is **not** sufficient to remove air contaminants.

Plume scavenging system (PSS) is the term used for a portable, mobile, or fixed device that captures and neutralizes plume. Plume scavenging systems are also known as smoke evacuators, laser plume evacuators, plume scavengers, and local exhaust ventilators.

PSSs generally consist of a filter system with activated carbon for trapping gases, an ultra-low particulate (ULPA) filter for particulates, and an intake that can be placed close to the source of the plume. When the exhaust system used by a PSS is a permanent part of the building, it shall not be combined with other utility systems within the building. The suitable airflow speed of the PSS for controlling

the airborne fumes will depend on the rate of plume generation and the exact system used.

The air suction ability of filters is significantly reduced when the filter has reached its capacity. Each PSS should have the capability to detect (e.g., pressure drop or a filter change indicator) if a filter is getting overload, or have a preventative maintenance plan based on filter service life and a change-out plan.

(Adapted from: CSA Standard Z305.13-13 "Plume scavenging in surgical, diagnostic, therapeutic, and aesthetic settings".)

The CSA Standard Z305.13-13 "Plume scavenging in surgical, diagnostic, therapeutic, and aesthetic settings" also requires that: *The facility have procedures and policies that are created and kept up-to-date that address the various hazards that may be present. Procedures should also address purchasing, installation, testing, use, servicing, and maintenance.*

INFECTION CONTROL

No clear universal standards are currently available for the cleaning and disinfection of laser devices. Members should consult the equipment manufacturer for any protocols that may be specified.

That noted the following should be thought of a minimum standard

Laser Body Disinfection

Prior to use, the exterior of the laser should be cleaned using a liquid disinfectant such as BIREX™, CaviCide®, or a 0.5% sodium hypochlorite solution. Do not spray the disinfectant directly on the chassis as liquids could damage the LCD displays and other sensitive switches. Apply with a gauze sponge or wipe. Allow the

surface to remain moist for 5 minutes (10 minutes for BIREX). Multiple applications may be needed to achieve the indicated contact time. Allow to air dry. Do not use abrasive materials to clean the system. Place an adhesive barrier material over the LCD screen prior to treating the next patient.

Fiber Cable and Hand-Piece Stem

Proper care and cleansing/sterilization of specific hand pieces should be integrated into treatment protocols. The exterior surface of the fiber cable and hand piece stem should be cleaned using a liquid disinfectant such as BIREX™, CaviCide®, or a 0.5% sodium hypochlorite solution. Do not spray the disinfectant directly on the cable or stem. Apply with a gauze sponge or wipe. DO NOT IMMERSE the hand piece stem as cleaning solution residuals could contaminate the optics in the stem and prevent laser transmission. Allow the surface to remain moist for 5 minutes (10 minutes for BIREX). Multiple applications may be needed to achieve the indicated contact time. Allow to air dry. Do not use abrasive materials to clean the system.

Other

Needles and other "*sharps*" are disposed of in appropriate containers. Linen soiled with blood rarely occurs in this type of care but must be treated as contaminated. Medical waste, disposal of syringes must be treated as biomedical waste and disposed of accordingly. Routine practices are described in detail in the COCOO guidelines: *Infection Control* .The CSA Standard Z305.13-13: "Plume scavenging in surgical, diagnostic, therapeutic, and aesthetic settings" also requires that all disposable PSS equipment including filters, capture devices, and hoses be considered biohazardous and that these items should be handled per the manufacturer's instructions or the facility's policy.

LASER MAINTENANCE AND SERVICE

Must be performed by qualified personnel as determined by the LSO.

Qualified service personnel may include the manufacturer's service technicians, third party service agents, or biomedical engineers. Such service personnel shall have documented laser safety training, and documented service training commensurate with the level of work they are performing on the laser. The

Member should also accept National Council of Laser Excellence (NCLE) National Council of Laser Certification (NCLC) Laser Certification of a repair technician as evidence of meeting this training requirement

Periodic Maintenance, including calibration checks, should be performed at six month intervals and/or per the original manufacturers schedule. The LSO shall maintain written service reports.
Many lasers are computer based and 'smart' so that they will perform several of these steps including: start-up calibration, safety checks and other parameters upon start-up, and can notify the user of equipment problems.

DOCUMENTATION & RECORDS

Members need to keep records and have them available on site, including:

- Laser operators authorized on the laser(s) found on-site
- Laser operator(s) qualifications, education, test results and safety training
- Standard operating procedures (SOP)
- Safety checklist:
    - Setup of laser controlled area with signs, window barriers, etc.
    - Confirmation of eyewear type and availability
    - Patient protection, including removal or covering of reflective surfaces (e.g. jewelry)
    - Safety equipment such as smoke evacuator, fire safety equipment, etc.
- Protective eyewear information
- Safety inspections
- Medical exam results
- Accident reports
- A record for each client showing the client's name, address, dates of treatment, type of treatment, etc.

All records must be typed or legibly written in ink and kept on site.

Samples of several documents including:

Laser Accident And Malfunction Report Form, Laser Utilization Record/Log, Laser Safety Checklist are available in *Appendix A,D & E.*

MEDICAL SURVEILLANCE & SAFETY INSPECTIONS

The only examination required for all personnel participating in laser work is an eye examination following suspected laser injury (usually within 48 hours of an incident). Periodic medical examinations are not required, nor are examinations at the termination of the person's responsibilities with the laser. At present, no chronic health problems have been linked to working with lasers.

However, a pre-assignment medical examination is recommended. The purpose of the pre-assignment examination is to establish a baseline against which damage (primarily ocular) can be measured in the event of an accidental injury. If the ocular history shows no problems and visual acuity is found to be 20/20 (6/6 in each eye for far and near) with corrections (whether worn or not), and Amsler Grid Test and Color Vision responses are normal, no further examination is required. Any deviations from acceptable performance will require an identification of the underlying pathology, as determined by the medical or optometric examiner. Incidental personnel need only have an eye examination for visual acuity. For further information on medical surveillance, see ANSI Z136.1-2007.

Periodic safety inspections of the laser treatment controlled area must also be performed by the LSO and Deficiencies must be documented and corrected immediately.

BIBLIOGRAPHY

- Medical Lasers: Quality Control, Safety Standards, and Regulations Joint Report Task Group No. 6, AAPM General Medical Physics Committee and American College of Medical Physics October 2001.
- Independent Health Facilities Clinical Practice Parameters and Facility Standards Laser Treatment of Benign Vascular Lesions 3rd Edition, March 2009, The College of Physicians, and Surgeons of Ontario.
- ANSI Z136.1, “Safe Use of Lasers.” American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018 (2000).

- ANSI Z136.3, "Safe Use of Lasers in Health Care Facilities." American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018 (1996). Andersen, Karen. Safe use of lasers in the operating room: what perioperative nurses should know. AORN Journal Jan. 2004.
- AORN Recommended Practices Committee. Recommended practices for laser safety in practice setting. AORN Jan 1, 2004 .
- Canadian Centre for Occupational Health and Safety (CCOHS). Lasers-health Care Facilities. www.ccohs.ca/oshanswers/phys_agents/lasers.html.
- Canadian Center for Occupational Health and Safety. Laser Plumes – Health Care Facilities.
- Canadian Standards Association (CSA) Standard- CAN/CSA-Z386-01: Laser Safety in Health Care Facilities.
- College of Podiatric Surgeons of British Columbia Practice Standards and Guidelines. Laser instrument and safety rules (2015).
- Accreditation standards Patient Safety Laser Safety – NHMSFP, College of Physicians and Surgeons of British Columbia (April 2015) .
- Laser Hair Removal Safety Guidelines for Facility Owners and Operators. Prepared by the Joint Documents Working Group of The Federal Territorial Radiation Protection Committee (First Edition, October 2011) .
- Laser safety: Risks, hazards, and control measures. Laser Ther. 2011; 20(2): 95–106. Penny J. Smalley, RN, CMLSO.
- Laser Safety Guides and Reference Materials, Laser Institute of America, 12424 Research Parkway, Suite 125, Orlando, FL, 32826.
- Laser Safety Training Programs and Videos, Rockwell Laser Industries, P.O. Box 43010, 7754 Camargo Road, Cincinnati, OH 45443.
- Lasers in Veterinary Practice: Safe Use Guidelines. College of Veterinarians of British Columbia, 2011.
- University of Mississippi Medical Center UMMC Laser Safety Manual 2014.