GUIDELINE FOR LASER SAFETY

The Guideline for Laser Safety was approved by the AORN Guidelines Advisory Board and became effective as of July 29, 2020. The recommendations in the guideline are intended to be achievable and represent what is believed to be an optimal level of practice. Policies and procedures will reflect variations in practice settings and/or clinical situations that determine the degree to which the guideline can be implemented. AORN recognizes the many diverse settings in which perioperative nurses practice; therefore, this guideline is adaptable to all areas where operative or other invasive procedures may be performed.

Purpose

This document provides guidance to the perioperative team on the safe use of **lasers**, the roles and responsibilities of personnel, and the educational requirements for personnel involved with use of a **laser system** for medical procedures.

The laser system consists of the laser, a delivery system that directs the output of the laser, a power supply with control and calibration functions, the mechanical housing, and the medium.[1] The light produced by a laser is a portion of the electromagnetic spectrum and may be infrared, visible, or ultraviolet. The type of light produced depends on the type of diode[2] or the material or medium inside the laser (eg, solid, liquid, gas).[3,4] The solid medium may be yttrium aluminum garnet (YAG) with neodymium (Nd), or it may be **doped** with holmium. The liquid medium is usually a dye, and the gas may be carbon dioxide (CO_2) or excimer.[4] The medium that is present is frequently used as a descriptor of the laser system (eg, Nd:YAG, CO_2).

The word "laser" is an acronym for light amplification by stimulated emission of radiation. Lasers are classified as 1, 1C, 1M, 2, 2M, 3R, 3B, or 4, which is based on the accessible laser radiation.[5,6] The majority of the lasers used in health care facilities are class 3R, 3B, and 4[1]:

- Class 3R laser systems present a low risk for injury, although the eye may be injured if it is focused and stable and the beam enters the eye directly or via **specular reflection**.[1] The **diffuse reflection** is usually not a hazard. Class 3R lasers are not hazardous to the skin and do not normally present a fire hazard.[1]
- Class 3B laser systems may be hazardous when the beam enters the eye directly or via specular reflection, but they do not normally cause a diffuse reflection or act as an ignition source.[1] The diffuse reflection is usually not a hazard. Class 3B lasers are not hazardous to the skin and do not normally present a fire hazard.[1]
- Class 4 laser systems are hazardous to the skin and to the eye when the beam enters the eye directly. They may be hazardous when the beam enters the eye via a diffuse reflection. Class 4 lasers also can present a fire hazard and may produce laser-generated air contaminants and hazardous plasma radiation.[1]

Lasers are used in a wide variety of settings (eg, offices, clinics, ambulatory surgery centers, hospitals) and procedures, including gynecologic, orthopedic, dermatologic, ophthalmologic, urologic, neurosurgical, cardiovascular, otolaryngologic, and cosmetic procedures.[1,7-13]

When the laser is activated, the beam can be reflected, scattered, transmitted, or absorbed. Reflection can be either diffuse or specular. The scattered beam may be absorbed or it may be **backscattered**. Absorption results in thermal damage to the tissue. The amount of thermal damage depends on the laser wavelength, beam fluence, radiance, chromophore consistency, water content of the tissue, the length of time of the application, and the temperature to which the tissue is heated.[5,12] The effects of the laser on the target tissue may be either a **photothermal interaction**, a **photochemical interaction**, or a **photomechanical/photoacoustic interaction**.[1,5,14]

The patient may experience various adverse effects or complications from laser treatment, depending on the area being treated. Adverse effects or complications include pain, edema, bleeding, purpura, infection, air embolism, hemorrhage, surgical emphysema, cellular damage around the area of laser impingement, skin pigmentation, scarring, reticulate erythema, ocular complications, and burns.[7,10,15-20] In a review of the Manufacturer and User Facility Device Experience (MAUDE) database, Zelickson et al[21] found 494 adverse events caused by the use of various lasers in dermatological settings between 2007 and 2011. The reported injuries to patients included blistering, burns, scarring, pigmentation damage, and infection.

The effects of the laser are considered beneficial if the laser beam reaches the intended target, but if it reaches a non-intended target, the effect can be an injury, and the beam is then considered hazardous. The hazards are generally categorized as beam hazards or non-beam hazards. Beam hazards can cause ocular and cutaneous injury. Non-beam hazards originate within the laser device itself or are created by the laser beam's interaction with materials in the surgical environment; these include laser plume hazards, fire hazards, and electrical hazards inherent in a high-voltage system.[22-24] The hazards to patients and personnel can be minimized by the use of personal protective equipment (PPE) and engineering, administrative, procedural, and special controls (eg, signage).[6,25]