Laser Physics and Safety in Surgery

Protecting our patients
Protecting others
Protecting ourselves

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By the end of this presentation, learner will be able to:

1. Define the characteristics of laser light and how it affects target tissue.
2. Identify the components of a laser system.
3. Explain the benefits of laser technology as it is used in surgery.
4. Identify commonly used lasers in the OR.
5. Describe safety precautions that must be practiced when using lasers.
Introduction

LASER is an acronym that describes a process in which light energy is produced

- **L** - light
- **A** - amplification by
- **S** - stimulated
- **E** - emission of
- **R** - radiation
**Light** is a form of electromagnetic energy that can be illustrated on a continuum known as the electromagnetic spectrum.
Characteristics of Laser light

**Monochromatic** - light is composed of photons of the same wavelength or color. In contrast, ordinary light consists of many different colors or wavelengths.

**Collimated** - consists of waves parallel to each other, which allows light to be focused into a tiny spot that highly concentrates the energy.

**Coherent** - all the waves are orderly and travel in the same direction, giving laser beam power.
Tissue Interaction

When laser energy is delivered to a target site, four different interactions can occur:

**Reflection** - the direction of the beam is changed after it contacts an area.

**Scattering** - beam spreads over a large area as tissue causes the beam to disperse.

**Transmission** - beam passes through fluids or tissue without thermally affecting the area.

**Absorption** - tissue is altered from the absorption of the beam.
Five major components of laser system:

**Laser head** - component in which laser energy is generated and amplified. Contains the active medium that generates laser light.

**Excitation source** - supplies the energy to excite the active medium in the laser head.

**Ancillary components** - other laser parts needed to help produce laser energy (i.e. cooling system)

**Control panel** - regulates delivery of laser energy

**Delivery system** - device that conducts laser energy from the laser head to target source.
Parts of a laser system

Ancillary Components

Control Panel

Laser head

Delivery System

Excitation Source

To target source
Benefits of laser technology:

1. Seals small blood vessels-less blood loss
2. Seals lymphatics- decreases post-op edema
3. Seals nerve endings- decreases post-op pain
4. Less scarring- decreases post-op stenosis
5. Reduces operative and anesthesia time
6. Provides quicker recovery
Commonly used lasers in surgery:

**CO2-**

- Uses a premixed gas of carbon dioxide, helium and nitrogen as the active medium.
- Highly absorbed by water
- The degree of tissue response is related to the amount of heat build up from absorption of CO2 beam
- Beam is delivered to target site through an articulated arm or laser fiber
- Commonly used in ENT and GYN procedures
Holmium:YAG -

- Crystal is the laser source
- Highly absorbed by water
- Can be conducted to target tissue through a flexible fiber
- Produces a vapor bubble that transmits laser energy within a short distance
- Commonly used in urology
**Argon-**

- Visible laser beam with blue-green light
- Highly absorbed by pigmented tissue
- Laser energy is converted to heat, causing coagulation or vaporization
- Delivered to target site through fiber or slit-lamp
- Commonly used in ENT and Ophthalmology
**KTP-**

- Beam is color selective and highly absorbed by hemoglobin and melanin
- Produces an intense green laser light
- Wavelength can be through clear solutions and structures
- Beam is conducted to tissue through a fiber
- Commonly used in Neurootology
**Diode (980)**

- Commonly used in treatment of BPH
- Laser energy can be delivered directly to tissue through a fiber
- Highly absorbed in both water and hemoglobin
- Provides a near bloodless procedure through both cutting and coagulation of tissue
Laser systems are capable of concentrating high amounts of energy within very small areas, which can present hazards. Healthcare facilities are required to have a comprehensive laser safety program in place.
The laser safety program includes:

1. Identification of laser hazards and control measures
2. Annual laser safety education and competency testing of associates
3. Management and reporting of accidents or incidents related to laser procedures
4. Laser service and preventive maintenance
ALL LASERS MUST BE TESTED AND APPROVED BY BIOMED PRIOR TO USE IN SURGERY.
General safety precautions

**Eye protection**-

- The eye is extremely sensitive to laser radiation and must be adequately protected during laser surgery.
- Everyone in nominal hazard zone must wear protective eyewear or use filters of specific wavelength and optical density for laser use.
- Patients must be appropriately protected (goggles or glasses, moistened eye pads, eye shields) depending on type of laser used.
**Smoke evacuation**
- Removes harmful plume during surgical procedures
- Should be held close to tissue interaction site to remove as much plume as possible
- Filters must be changed according to manufacturer’s instructions

**Skin protection**
- The distal tip of the laser fiber should be directed at the target tissue to prevent exposure on unprotected skin
Laser Procedure guidelines:

**Laser Operator:**

- Require additional competency training in addition to annual laser safety in-services
- Laser must be tested by operator prior to patient room admission
- All safety equipment must be inspected and available to patient, procedure staff and on any entrances to procedure room
- Room entrances must be RESTRICTED with warning signs posted, and windows covered prior to use
- Any complications or issues regarding laser use must be immediately communicated to charge nurse
**Circulator roles:**

- Knowledgeable of precautions for each particular laser
- Dispenses sterile water or saline to operative field
- Flammable preps are not to be used
- Ensures patient safety throughout procedure
- Documents details regarding laser use in meditech
**Scrub roles:**

- Knowledgeable of precautions for each particular laser
- Sterile water or saline should be readily available on the field
- Sponges or towels near the target site should be kept wet
- Instruments used in the vicinity of laser treatment should be nonreflective
- The whereabouts of the laser is monitored at all times
Anesthesia and Lasers:

- PVC Endotracheal tubes (ETTs) are highly flammable, especially when using O2 during anesthesia administration
- Laser-retardant ETTs should be used during oral, tracheal or esophageal laser procedures
- ETTs should be inflated with tinted saline
- Nonexplosive gases should be used during laser procedures
- In case of endotracheal fire:
  - Stop ventilation, disconnect gas flow
  - Extinguish all flames with saline
  - Remove ETT
  - Ventilate patient by mask or reintubate
  - Examine the airway for burns or foreign bodies
Fire safety protocols:

• Ensure sterile water or saline is immediately available on the field to douse small fire
• Know location of and how to operate laser-appropriate fire extinguisher
• Use wet towels, nonflammable drapes near the laser target area
• Do not use flammable materials near the laser impact site
• Allow flammable skin preps to thoroughly dry
• Only activate the laser when the delivery tip is within the user’s direct field of vision
IMPORTANT

KEEN AWARENESS TO THE SURGICAL FIELD IS KEY IN PREVENTING A LASER INDUCED PROCEDURAL FIRE.

USE CURRENT FIRE SAFETY PROTOCOLS.
Documentation

Complete documentation of laser procedure is required in laser log and Meditech:

- Laser operator
- Patient information (name, RA and RM, birth date)
- Type of laser used, manufacturer and serial number
- Laser fiber- size, manufacturer, reference and lot numbers, expiration date
- Surgeon
- Surgical procedure
- Laser settings and parameters
- Safety measures implemented during case
- Patient protection
Laser use in surgery can pose serious risks to both patients and staff. Understanding:

- how they work
- safety measures that need to be followed
- your important role in the laser safety program

will lead to a successful outcome for all!
References:


Laser Safety in Surgical Services. Kristin Varnes RN, MSN, CNOR

OSHA Technical Manual, Section III, Chapter 6. Laser Hazards