Safety Concepts
in the Surgical Setting

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The operating room is a place commonly associated with the elimination of disease and restoration of normal body function for its patients. It is, though, one area of the health care facility that potentially includes a significant number of hazards for both the patient and the staff. Keeping both groups free from injury is an important component of the surgical experience. The role of the operating room professional mandates that the O.R. staff assure the creation and maintenance of a safe environment before, during, and after the surgical intervention. This article examines the hazards and dangers commonly associated with surgical practice and some of the practices and safeguards in place to assess and address these issues.

PHYSICAL AND PSYCHOLOGICAL HAZARDS

The primary goal of the patient intervention is to provide a safe and positive operative experience. The operating room, by its nature, is an environment that contains numerous sources of potential injury for the patient. In addition, patients coming to the O.R. often experience alterations in decision-making abilities induced by stress, medications, or other factors that can significantly contribute to iatrogenic injury. It is the duty of the team to ensure that the patient's O.R. experience is safe. This can be achieved by following health care facility policies and procedures, the proper use of equipment, and the implementation of basic safety practices.

PHYSICAL DANGERS

Stretchers on wheels, narrow operating room tables, an unfamiliar environment, and sensory overload can all contribute to a potential for physical patient injury. The primary causes of physical injury include falls and positioning injuries.

Falls

Operating room tables and stretchers are specifically designed with narrow dimensions to meet the needs of the operating room environment and the O.R. team. Safeguards that are implemented to address the concerns related to falls include:

1. Never leave a patient in the operating room setting (holding area, O.R. suite, PACU, etc) unattended. An anxious or medicated patient may "forget" that he or she should not get up or move around, contributing to a fall and possible injury.
2. Side rails and/or a patient safety belt should always be used when a patient is resting on a narrow surface (O.R. table) or a moveable surface (stretcher). The safety belt should be applied in a position to restrict patient movement, but should not be applied so securely that the patient experiences hyperextension of joints or undue skin pressure. For those patients who are young and might attempt to climb over side rails, an enclosed transport/crib should be utilized.
3. When the patient is moving between two surfaces, such as the stretcher and the O.R. table, a minimum of two persons, one on each side of the stretcher and the table, should be available to guide the patient in a safe transfer. Reliance on the break mechanism on the stretcher for stability can leave the patient at risk for injury. When the staff is transferring the patient, a minimum of four people, one on each side of the patient, is required for a safe and effective transfer.

Positioning injuries

Surgical positioning and the use of positioning devices have a potential to lead to physical injury. The anesthetized patient may not be able to "complain" of hyperextended joints or undue pressure on the skin. It is the responsibility of the O.R. team to assure patient comfort by implementing the following practices:

1. Never hyperextend a joint or abduct a joint greater than 90 degrees from midline. Abduction of the upper extremities greater than 90 degrees can lead to brachial plexus palsy and neurovascular compromise.
2. Pad all pressure points, especially over bony prominences.
3. Never place patient skin against "plastic" or non-absorbent surfaces. The moisture secreted by the skin during the operative

intervention can lead to skin maceration and breakdown.

4. Use extreme caution when raising and/or lowering the foot section of the O.R. table. Patient fingers can easily fall across the break of the bed, and can result in finger crushing.
5. Use care when placing the patient in the lithotomy position. Ensure that both lower extremities are raised/lowered, rotated and moved in a mirrored fashion. This prevents hyperextension of any one of the numerous joints involved with attaining this position and subsequent neurovascular injury. It is advisable to have two people involved in positioning the lower extremities, one managing each limb.
6. Never use the patient as a "Mayo stand" by placing large numbers or heavy instruments on a draped patient's extremities or torso.
7. Monitor and control the position of drains, tubings, and catheters during the patient's transfer to eliminate accidental dislodgment.

Electrical dangers

The energy source for most modern technology used in the operating room suite is electricity. While electricity will flow within a circuit, any disruption in that circuit, or the creation of an alternative pathway to ground, can serve to include the patient within the electrical circuit. This can lead to inadvertent thermal burns from concentrated electrical flow. The electrosurgical unit, used in almost every operative intervention today, purposefully passes electrical current through patient tissue for the purposes of coagulation and desiccation of tissue. It is important that patient safeguards are utilized to ensure that the electricity returns to the generator without unintended patient injury. This is accomplished by proper application and use of patient return electrodes (grounding pad) for monopolar electrosurgery, and the assurance that all patient skin is not in contact with metal surfaces on the O.R. table.

Lasers, the use of amplified light waves concentrated to a point where they can vaporize tissue and cellular fluids, have added a valuable tool to today's surgical setting. While the advantages of using lasers are numerous, the inherent danger of controlling light emission is compelling. Stray laser beams from some types of lasers can travel distances, causing thermal injury at the point of contact. Tissues particularly vulnerable to the effects of laser application include the retina of the eye, thus laser safety glasses or other appropriate eye protection devices are required during laser usage. (See sidebar pg 256.)

Mechanical dangers

The concepts of pressure and shear force are commonly associated with a surgical intervention. Pressure, the application of a force greater than the tissue resistance, can decrease blood flow to the point of creating ischemia, necrosis, and even gangrene. Pressure points on the body include those areas where bony prominences underlie thin adipose tissues and skin layers. Common locations for pressure points include the occipital area, the ear, nose, chin, elbow, pelvis, and heel. During surgery, the patient is rendered immobile by the use of anesthetic agents and is unable

to redistribute his or her weight when increased pressure on an area is detected. The goal of the O.R. team is to reduce the pressure created by an immobilized patient on a firm surface. This can be accomplished by using padding, such as gel pads and pressure relief viscoelastic foam pads under these susceptible areas.

Shear is the force created on skin by the movement of the underlying tissues. This results in compression of blood vessels, which decreases blood flow to the area. Shear force is generated when the body slides on a bed surface, and it contributes to skin breakdown in compromised and immobile patients. It can also occur when a sheet or johnny is "pulled out" from underneath a patient without turning the patient side to side. The use of proper positioning, transferring, and turning techniques will minimize skin injury caused by friction and shear forces.

Thermal dangers

Burns

Burns, or thermal tissue injury, can occur as a result of many activities in the operating room. The application of a "hot" instrument from the "flash" autoclave, fiberoptic light sources, fiberoptic cords placed on drapes or near patient tissues, the use of irrigating fluids that have been warmed to greater than body temperature, all serve as potential causes of thermal injury. The surgical technologist has the obligation to prevent thermal injuries by controlling fiberoptic

Laser Hazards and Eye Protection

A laser serves as a nearly ideal point source of intense light. A sufficiently powerful laser beam can possibly produce retinal intensities that exceed conventional light sources, including those produced when directly viewing the sun. Consequently, viewing lasers can result in permanent blindness. Direct exposure on the eye by a beam of laser light should always be avoided with any laser, no matter how low the power. Eye protection requires that O.R. personnel be thoroughly familiar with two terms, maximum permissible exposure (MPE) and nominal hazard zone (NHZ).

The American National Standards Institute (ANSI) defines MPE as the level of radiation that an individual may experience without hazardous effects or biological consequences to the eye or skin. The MPE is based on the laser wavelength, exposure time and pulse repetition. According to ANSI, the NHZ is the space where the level of the direct, reflected or scattered radiation during the use of the laser exceeds maximum permissible exposure. Essentially, it identifies the area where safety measures must be mandated. In the operating room, the entire space is considered the NHZ, and appropriate protection is required for any staff member entering the O.R. when a laser is being used.

Lasers are often employed in the operating room for excision and cauterization of tissue. The operating room staff should be very conscious of the health care facility's policies regarding laser safety. Even the exposure to a small amount of laser light can cause permanent eye injuries. The O.R. team member may be unaware of an exposure to laser radiation (particularly the invisible light). Some lasers are powerful enough to diffuse the reflection from a surface which can unexpectedly cause damage to the eye. Eye injuries are primarily the result of the thermal effects experienced by the retina. A transient increase of only 10 degrees C can cause the photoreceptors in the retina to be destroyed.

Such damage can occur within a fraction of second because of the low divergence angle of laser light combined with the focusing mechanism of the eye which allow the laser light to be concentrated into an extremely small spot on the retina. An injury may be sustained faster than the blink of an eye. Visible to near infrared radiation will penetrate the eyeball and cause heating of the retina. Exposure to lower wavelengths of laser radiation results in the development of cataracts or burns, because the light is absorbed by the cornea and lens.

Particularly dangerous in the operative environment are infrared lasers which are invisible to the O.R. personnel. The Nd:YAG laser beam, which is in the near-infrared electromagnetic spectrum is commonly used in the O.R. for vaporizing bladder tumors, laser bronchcoscopy and laparoscopy. If a team member has been exposed, he or she may not feel pain or notice immediate damage to his or her eyesight. A pop or clicking noise may be heard indicating that the retina was overheated and a localized boiling resulting in a permanent blind spot may be a consequence.

Based on the potential for biological damage, there are four classes of lasers:

- **Class 1** lasers represent the least dangerous applications of light energy and are regarded as incapable of producing damaging levels of laser emission.
- **Class 2** lasers produce visible laser emissions and may be viewed directly for .25 seconds or less. (The time it takes for a blink of an eye or a head swing).
- **Class 3a** lasers are regarded as dangerous

cords, and checking fluids and instruments for proper temperature prior to patient application.

Fire

The operating room is a prime location for fire to occur. The necessary components for fire ignition—oxygen, a fuel source, and source of ignition—are all readily found in the O.R. environment.

Some of the practices of concern that need to be carefully monitored by the health care team include:

1. Care during the use of flammable skin preparation solutions, such as alcohol and tinctured or alcohol-based solutions
2. Care during the use of flammable liquids and anesthetic gases, such as inhalation agents
3. Caution in the presence of ignition sources, such as electrosurgical pencils and lasers, especially near oxygen sources, such as in surgery of the larynx or mouth
4. Monitoring fiberoptic light cords on the sterile field, particularly when placed on, or near, disposable draping materials and the use of standby light settings when light cords are not attached to telescopes
5. Wearing non-cotton garments by O.R. staff, which may produce static electricity
6. Venting heat generated from electrical equipment away from the surgical field and the anesthesia machine

under direct or reflected vision. These lasers are restricted to the visible electromagnetic spectrum.

- **Class 3b** lasers are considered hazardous when viewed intrabeam and may extend over the entire electromagnetic spectrum.
- **Class 4** lasers are the highest energy class of lasers and also extend across the electromagnetic spectrum; they can cause serious damage to skin and eyes.

In the operating room, the most commonly employed lasers belong to class 3b and class 4.

Below is a list of the potential hazards to eyes when working with lasers.

Light Source	Injury to Eye
Ultraviolet C (0.200-0.280 µm)	Photokeratitis
Ultraviolet B (0.280-0.315 µm)	Photokeratitis
Ultraviolet A (0.315-0.400 µm)	Photochemical UV cataract
Visible (0.400-0.780 µm)	Photochemical and thermal retinal injury
Infrared A (0.780-1.400 µm)	Cataract, retinal burns
Infrared B (1.400-3.00 µm)	Corneal burn Aqueous flare IR cataract
Infrared C (3.00-1000 µm)	Corneal burn only

In the operating room, eye protection is designed to protect against radiation from a specific laser. This generally applies only to Class 3b and Class 4 lasers. The effectiveness of eyewear is critically dependent on the frequency of use. Selecting the right type of eye protection is important. Protective eyewear must be able to block the laser radiation when it strikes the lens portion, or at the minimum reduce the radiation to a permissible exposure level. This protection level is defined as the optical density (OD). Two important factors influence the type of eye protection chosen—wavelength coverage and optical density. Commonly, these specifications are imprinted on the safety goggles. For example, a pair of Nd:YAG goggles may be imprinted with "for use with 1064 nm." It should be noted that the lens color of the goggles is not related to the protection against the laser beam.

For procedures using ultraviolet and infrared laser radiation, the OD chosen by the team members should provide full protection. For example, using the chart to the left, goggles rated to protect against ultraviolet C would not be effective protecting an individual who was exposed to Infrared A.

In addition to the O.R. team, the patient's eyes must also be protected by moistened gauze pads, or appropriate safety goggles or glasses.

Health care facility policies will recommend the frequent inspection of laser goggles in order to detect cracks or breaks A scratched surface permits the transmission of laser light and possible injury. In addition to the actual operating room personnel, other employees who walk by the surgical room must be protected and windows are therefore covered as necessary. To prevent reflection, instruments that are not dulled or ebonized, should be covered with wet towels or sponges.

Surgical technologists may be asked to undergo an ocular examination when hired to work in a surgery using lasers and another examination upon resignation or termination of employment. These eye examinations establish necessary baselines and protect the employee and the hospital. Laser safety should be considered a critical priority of the O.R. staff and health care facility. Inquire about policies where you work and be sure that you are well informed and up to date regarding laser safety.

7. Ensuring electrical cords and wall plugs are intact and appropriately grounded
8. Ensuring proper environmental humidity is maintained to reduce the potential for static electricity formation

Chemical dangers

Antiseptic solution use

Antiseptic agents, used to decrease the transient and resident microbe population of the patient's skin prior to, and during, the surgical intervention, can cause skin irritation with prolonged contact and application. Povidone-iodine solutions that have been warmed are more prone to causing contact dermatitis, especially in patients with delicate skin, such as the young, elderly, or when contacting tissues of the perineum. Antiseptics should only contact the skin for as long as necessary. Excess prepping solution should not be allowed to pool on patient skin surfaces and should be removed at the end of the procedure during dressing application.

Cold chemical sterilant use

Activated glutaraldehyde and peracetic acid, chemicals used for cold disinfection and sterilization of surgical instruments and equipment, can be caustic to the skin of both the patient and the health care worker. Care should be taken to ensure that all traces of activated glutaraldehyde and peracetic acid have been removed by rinsing with sterile water prior to contact with patient skin or mucous membranes.

Latex sensitivity and allergy

Natural rubber latex is a chemical used in the manufacture of supplies employed in the operating room. The protein in natural rubber latex serves an antigen in selected patients, triggering an immune system response in susceptible individuals. This response can range from contact dermatitis to full-blown anaphylaxis, and even death.

Patients at risk for developing latex sensitive and/or allergy include[3]:

1. Those who possess a known or suspected allergy to latex by having exhibited an allergic or anaphylactic reaction, positive skin testing, or positive IgE antibodies against latex
2. Those with documented history of intraoperative anaphylaxis of unknown etiology
3. Those with neural tube defects including:
   – Spina bifida
   – Myelomeningocele/meningocele
   – Lipomyelomeningocele
4. Those who have experienced some interaction between their central nervous and immune systems
5. Those who have had multiple operations, particularly as a neonate
6. Those who require chronic bladder catheterizations as a result of:
   – Spinal cord trauma
   – Extrophy of the bladder
   – Neurogenic bladder
7. Those who possess some history of multiple allergies including food products, particularly bananas, avocado, celery, fig, chestnut, papaya and passion fruit

Proper care of the patient is essential to his or her safety from anaphylactic reactions and to assure an ideal outcome. Recommended practices should be developed and implemented within each health care facility. These practices may include:

- scheduling a latex-sensitive patient as the first procedure of the day;
- identification of O.R. products and equipment that contain natural rubber latex and replacing them with latex-free products, or protecting them from contacting patient skin;
- developing a committee to focus and monitor issues related to latex sensitivity; and
- using non-powdered gloves in the O.R. setting

Radiation

Radiation is invisible. The effects of radiation exposure are seen most readily on the cellular level, where they can change the electrical charges of atoms within cells, altering genetic material, even when used in therapeutic doses. Those tissues most susceptible to changes from radiation exposure include the thyroid gland, the lens of the eye, bone marrow, and the ovaries/testes.

In the operating room, radiation is used in the forms of fluoroscopy, X-ray, and radioactive substances. Fluoroscopy is a technique that provides live images of internal structures during an operative intervention. These images are used to guide implantable device placement, check for alignment of bones, or the recording of images outlined using contrast media. X-rays are used when live imaging is not necessary, but is less frequently used in today's O.Rs, being replaced by more frequent use of fluoroscopy. Radioactive substances may be injected into the patient prior to arrival in the O.R. suite, or may be implanted during a surgical procedure for the detection or treatment of neoplasms. The effects of radiation seen are related to the amount and length of an exposure. The goal of protection for both staff and patient is to minimize exposure to radiation while permitting diagnosis and monitoring of interventions. Safety interventions can include minimizing the time and length of exposure during fluoroscopy and X-ray; applying lead shielding over the portion of the patient's body that does not need to be viewed; tight focusing the radiation beam, whenever possible; and protecting the unborn fetus from radiation exposure in the pregnant patient.

PSYCHOLOGICAL ASSAULT

The sense of hearing is the last sense to leave and the first to return in the patient undergoing general anesthesia. Patients are acutely aware of the sounds in the O.R. environment, and "assume" that any and all conversation is related to them and their care. It is important that the patient be protected from psychological assault, by the implementation of the following practices:

1. Minimize extraneous O.R. noises and traffic, especially when the patient is awake.
2. Focus all conversation within patient hearing on the issues and needs of that patient. All other conversation should be conducted outside the patient's range of hearing.
3. Use positive communication techniques during patient-focused conversation.
4. Avoid the use of "trigger phrases."

Through awareness of the dangers present in the O.R., the surgical technologist can play an instrumental role in providing a safe and positive therapeutic environment.

SAFEGUARDS IN SURGICAL PRACTICE

Standards of Practice

Guidelines for patient safety have been established by many organizations both directly and indirectly related to surgical practice. In 2004, the AST Education and Professional Standards Committee began researching practice issues after it was recognized that there was a need for a comprehensive publication focused on evidenced-based standards of practice. Recently, AST published several recommended standards of practice, position and guideline statements both in print and online. In the near future, additional topic areas will be published. It is anticipated that these standards of practice are considered dynamic and will change as needed to reflect advances in technology and care practices.

In addition to AST, other organizations and nursing groups in the US, Canada, Australia, and Great Britain, such as the Association of Perioperative Nurses (AORN) have published standards of practice that guide perioperative practice.

The Joint Commission requires hospitals to implement written policies and procedures for patient care. Hospitals voluntarily undergo The Joint Commission accreditation review every three years to measure compliance with established standards of practice. Successful attainment of The Joint Commission accreditation is a requirement in order for hospitals to receive JUA (Joint Underwriter's Association) malpractice insurance.

In 1965, the US Federal Medicare Act was passed, providing medical coverage to individuals 65 years of age and older, or to those with disabilities. When the Medicare Act was introduced, it included policies and procedures that impact health care delivery. Additional federal agencies that have established policies and procedures that affect surgical practice include the Federal Food and Drug Administration (FDA) and Occupational Safety and Health Administra-

tion (OSHA). Other national organizations that have developed regulations, policies, and procedures utilized in the care of surgical patients include the National Fire Protection Association (NFPA), the Association for Advancement of Medical Instrumentation (AAMI), and the American National Standards Institute (ANSI).

Quality assurance

Quality assurance involves the implementation of methods and processes to measure the quality of patient care, based on the standards of practice established by the health care facility. The American Hospital Association's (AHA) Patient's Bill of Rights states that each and every patient is entitled to the same level of care, regardless of his/her ability to pay for that care or any other external factor. Hospitals are required to internally and externally monitor the level of quality care delivered. There are several methods for documenting quality care.

Audits

An audit is a review examination of records or accounts to check their accuracy. In the hospital setting, audits are commonly performed to determine the level and quality of care delivered to any given patient population. This review indicates the degree of compliance with the hospital's established policies and procedures

Peer review

Fellow employees perform peer audits within a department. These audits are required by The Joint Commission as part of an ongoing assessment process. In the operating room, peer audits may be performed to evaluate compliance in applying patient safety devices, management of sharps, proper O.R. attire, and many other areas that directly or indirectly affect quality patient care.

Professional Standards Review Organization

Quality assurance for recipients of federal Medicare and Medicaid programs is overseen under the auspices of the Professional Standards Review Organization (PSRO). This organization was formed by the 1972 amendments to the Social Security Act with the purpose of reviewing the quality of medical care received by its beneficiaries, ensuring necessary, appropriate, and consistent quality of care. The PSRO has the right to review patient charts and examines the documentation of care delivered retrospectively, in order to audit the level and quality of that care.

The Joint Commission, like the PSRO, will also perform routine retrospective audits of patient charts and review the documentation to assess the level and quality of care.

CONCLUSION

Among the many challenges faced by the patient in today's operating room, none is of greater importance than safety. As professional practitioners, it is our responsibility and obligation to minimize the risk of patient and staff injury from the various hazards and dangers inherently part of the operating room experience. Minimizing and eliminating hazards in the surgical setting follow one of the basic tenets underlying all health care practice: primum non nocere—first, do no harm.

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