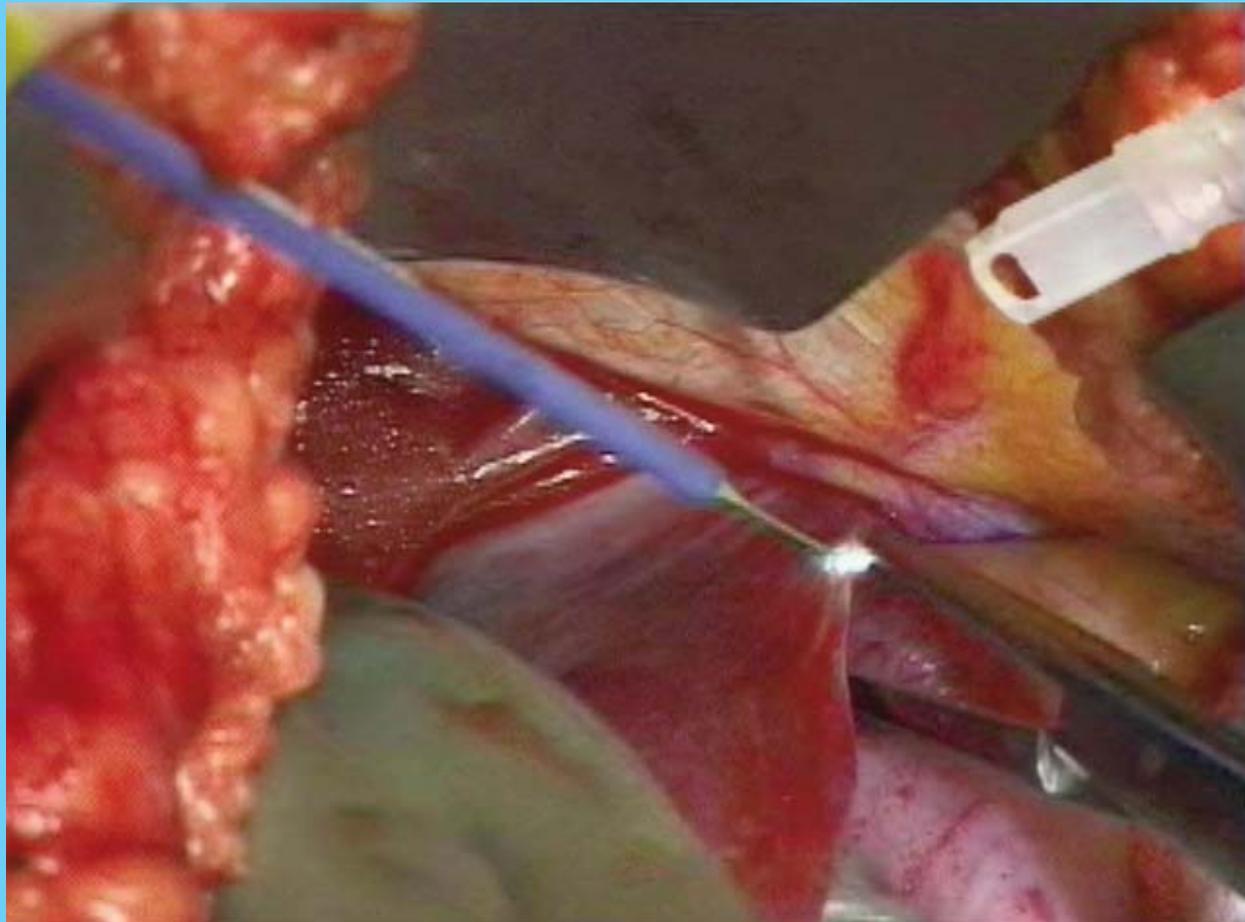


**ELECTROSURGERY  
FUNCTION, PRACTICE, AND SAFETY**

1937



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**ELECTROSURGERY FUNCTION, PRACTICE, AND SAFETY**

AORN VIDEO STUDY GUIDE  
 AORN INDEPENDENT STUDY ACTIVITY



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**PURPOSE/GOAL**

The purpose/goal of this activity is to provide perioperative nurses with important information related to the use of electrosurgery.

**OBJECTIVES**

After viewing the video and completing the study guide, the learner will be able to

1. identify three measures that promote safe use of electrosurgical equipment, and
2. describe potential risks associated with the use of monopolar electrosurgical equipment during minimally invasive surgery.

**GUIDE FOR STUDY**

This study guide is intended to be used in conjunction with the accompanying video. We suggest that you take the following steps to complete this activity.

1. Read the overview and objectives for this educational activity, and compare them with your own learning objectives.
2. View the video.
3. Read the study guide, paying particular attention to those areas that reflect the objectives.
4. Consult a dictionary for definitions of unfamiliar words.

**INTRODUCTION**

Electrosurgery, the use of high-frequency electrical current for cutting and coagulation of tissue, has become a technique used daily in most surgical specialties. Acting as a patient advocate, the perioperative nurse has become one of the designated caregivers responsible for the proper use, daily maintenance, and preparation of electrosurgical equipment and accessories.

The use of electrosurgical current can enhance the patient’s favorable outcome by

- reducing surgical time,
- minimizing bleeding, and
- decreasing the amount of tissue destruction.

Although these positive outcomes have become routine expectations, considerable risks remain. During electrosurgery, high-frequency, high-voltage, electrical energy is delivered, which can become hazardous if not used with respect and knowledge. To provide and maintain a safe environment for both patient and personnel, the perioperative nurse must possess a heightened awareness of basic electrosurgical principles, as well as potential risks associated with electrosurgery. Today’s surgical suite has become a highly technical, innovative, fast-paced arena, so the perioperative nurse also must understand and actively participate in measures aimed at controlling these risks.

**ELECTRICITY: THE BASICS**

Although electrosurgical units are used multiple times each day in perioperative settings, they are poorly understood. In a February 2005 survey by ECRI, 30 percent of facility members reported that patients had experienced electrosurgical burns. An even more astounding finding was that 30 percent of those respondents did not have any idea how the burns occurred.

To understand electrosurgical principles and safety, it is necessary to have a basic understanding of electricity. Electricity, the flow of electrons, is often compared to the flow of water. Quantities of water are measured by pounds and quarts, whereas electricity is measured in amperes (amps). One amp is equal to a specific number of electrons flowing per second.

Voltage is the force that drives these electrons through the conducting wire much the same as gravity is the driving force for water. Any opposing force to either flow is called the resisting force. Electrical resistance is measured in ohms. These three electrical concepts (amps, voltage, and resistance) are interrelated by Ohm’s law where:

$$\text{Current (amps, indicated I) = Voltage/Resistance}$$

$$I = V/R$$

Power (watts) is the energy produced over a period of time and measured in joules/second.

$$\text{Power (watts) = Voltage x Current (amps)}$$

$$P = VI$$

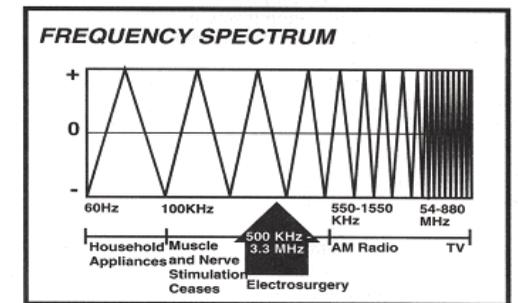
Current flows only in a complete circuit. This flow is from areas of greater potential to those of lesser potential. Current flows through the path of least resistance (Table 1). Current flowing in one direction, from a source to a destination and back again to the source, is known as direct current (DC). Current is completed when the return takes place and the electrons are only flowing in one direction. An example of direct current is electricity flowing from a battery.

**PROPERTIES OF ELECTRICITY**

CURRENT =	FLOW OF ELECTRONS DURING A PERIOD OF TIME, MEASURED IN AMPERES
CIRCUIT =	PATHWAY FOR THE UNINTERRUPTED FLOW OF ELECTRONS
RESISTANCE =	OBSTACLE TO THE FLOW OF CURRENT, MEASURED IN OHMS (IMPEDANCE = RESISTANCE)
VOLTAGE =	FORCE PUSHING CURRENT THROUGH THE RESISTANCE, MEASURED IN VOLTS

**Table 1** - Properties of Electricity (Courtesy of Valleylab Inc., Boulder, CO)

Alternating current (AC) is just as one might expect; the current periodically switches directions of flow. The frequency of alternations (changes in direction) is measured in cycles per second or Hertz (Hz). Power lines generally produce AC at 60 cycles/second (60 Hz), which is a relatively low-frequency current. It can electrocute if allowed to travel through the body and causes nerve and muscle stimulation. This depolarization resulting in tissue excitation does not occur at frequencies greater than 100,000 Hz (the high-frequency range). By design, electrosurgery operates at the low end of the radio frequency range of 250,000 to 3,000,000 Hz. The radio frequency spectrum extends to greater than 500,000,000 Hz, as illustrated in Fig. 1.



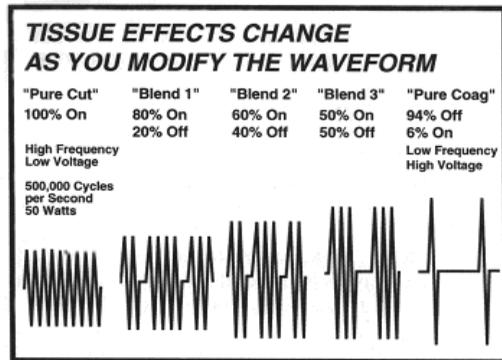
**Fig 1.** - Frequency Spectrum (Courtesy of Valleylab, Inc., Boulder, CO)

## ELECTROSURGICAL EFFECTS ON TISSUE

Although electrocution as well as nerve and muscle excitation does not occur during high-frequency electro-surgery, other tissue responses are produced. Current entering tissue excites ions in the cell, causing a release of kinetic energy. When this happens, a thermal effect is produced and the cell's temperature rises. The amount of heat produced varies with tissue resistance, amps, and length of time current is applied.

Water and electrolytes are found in high quantities in cells. They act as ideal conductors for electrical current. The better the conductor, the less the resistance and, therefore, the less the tissue is heated. Tissue resistance varies depending on the type of tissue and water content. Dry, devitalized tissue and skin produce high resistance.

Electrosurgical generators are capable of producing different waveforms. Each waveform produces a different tissue effect. The three desired tissue effects are cutting, fulguration, and desiccation (Fig. 2).



**Fig. 2** - Tissue Effects Change As You Modify the Waveform (Courtesy of Valleylab, Inc., Boulder, CO)

A constant waveform produces a cutting effect and heats tissue so rapidly that cells are vaporized. Water in the cell becomes so hot, the cell explodes. Small sparking also occurs, adding to the cutting effect. Tissue damage from a cutting current is confined to a very small, shallow region under the electrode. Cells adjacent to the

electrode are vaporized, and cells a few layers deep are essentially undamaged. Generally, only smaller vessels are sealed when cutting is used.

Coagulation, through the use of an intermittent wave form, produces less heat; therefore, cells are not vaporized. Instead, a coagulum is produced. Coagulation is used to close larger vessels as well as to destroy areas of tissue. Tissue damage, therefore, is deeper, and is a cumulative thermal damage.

Fulguration (spray coagulation) occurs when there is sparking during use of the coagulation waveform. Tissue is carbonized by the arc strikes, and sparking occurs, which coagulates and chars tissue over a wide area but does not cut. Fulguration is accomplished by holding the electrode away from the tissue and allowing the arcs to randomly spray onto the tissue. This is how most surgical hemostasis is accomplished. Spray coagulation requires high current as well as high voltage. Intermittent (not constant) bursts of high-voltage, modulated current produce this effect.

Desiccation occurs when the electrode is in direct contact with tissue. As the current passes through tissue, heating and coagulation occur. Any waveform can be used, but the effect is best achieved with the cutting current. During desiccation, the cell's water slowly evaporates. The cell shrinks, but cellular function is preserved.

To obtain cutting with hemostasis, blended cutting and coagulation waveforms must be available. The two waveforms need to be combined before to output from the generator.

Variables other than waveform that determine electro-surgical effects on tissue are

- power setting,
- electrode size/shape,
- contact time,
- tissue type, and
- eschar.

Electrode size can determine the electrosurgical effect on tissue. Smaller tips create a higher concentration of current. Eschar provides high resistance to current. It is important to keep the electrode tip clean to lower resistance.

## MONOPOLAR VS BIPOLAR MODALITIES

Electrosurgery can be performed in either a monopolar or bipolar mode. In the monopolar mode, current travels from the generator to the active electrode, through the patient to the dispersive pad, and then back to the generator. Bipolar technology incorporates an active electrode and a return electrode into a two-pronged instrument. Current flows from the generator to the active electrode prong, across the tissue to the return electrode prong, and then back to the generator. There is no need for a dispersive electrode when bipolar electrosurgery is used.

## ADVERSE EFFECTS DURING ELECTROSURGERY

Adverse electrosurgical effects/injuries can and do occur. The most commonly reported injuries are dispersive electrode burns, active electrode burns, and alternate site burns.

### Dispersive Electrode (Pad)

A dispersive electrode (pad, plate) is a conductive surface applied to an area of the patient's skin that allows the high-frequency current to pass from the patient back into the generator, thus making a complete circuit. At the treatment site, the current enters the body through a highly concentrated area, resulting in the desired cutting or coagulation effect. Dispersion of current at the return electrode should be over a relatively large surface area so that there is no focus of energy that could result in tissue damage. Pad contact is even less compromised when using a dispersive pad that has adhesion over its entirety. If this surface area is significantly reduced (as when patient-pad contact is inadequate), the dispersive electrode has the potential to become a treatment electrode.

When the contact area is decreased, current density is increased, and more heat is generated per unit area. This increased heat can result in a patient burn. If the dispersive pad is placed appropriately, the electrosurgical generator can be used at the lowest possible power setting to accomplish the desired effect.

Choose a dispersive electrode in an appropriate size for the patient. The pad should never be cut or folded to fit. Place the electrode on clean, dry skin, over a large, well-perfused muscle mass as close as possible to the surgical site. Muscle conducts electricity better than adipose tissue. Avoid bony prominences, scar tissue, hairy surfaces, or surfaces distal to tourniquets, because these can impede electrosurgical return current flow. Other dispersive electrode sites to avoid include sites over an implanted metal prosthesis and over tattoos, which may contain metallic dyes.

Impedance, a restriction in the flow of alternating current that occurs when the current encounters resistance, increases as the dispersive pad is moved farther from the treatment site. Impedance is reduced over well-perfused areas of the body because blood flow is supportive of electrical current conduction. As previously mentioned, skin is highly resistant to electrosurgical current. To decrease this resistance, the dispersive pad must be coated with a good, non-drying, conductive medium.

### Return Electrode Monitoring

With the development of the isolated generator, alternate site burns are rare. The isolated generator does not prevent dispersive electrode burns, however. Many of these burns can be eliminated by using a return-electrode, contact-quality monitoring (RECQM or REM) system. The system continuously monitors the patient return electrode contact and disengages power if this contact quality is compromised. Contact quality is compromised when

- there is decreased surface area contact between the patient's skin and the surface of the dispersive electrode
- OR**
- there is a lack of conductivity between the patient's skin and the surface of the dispersive electrode.

When either of these conditions is present, there is an increased resistance to the flow of returned current. As this impedance increases, so does the temperature of the tissue, and a burn develops.

The RECQM system measures this impedance. If the impedance increases above a predetermined level, the unit alarms and deactivates. The system operates by sending a separate and distinct monitoring current to the patient dispersive pad. This current passes from one conductive section of the dual section pad to the next section of the pad by flowing through the patient. It then returns to the generator. The current operates on a different frequency than that of the therapeutic current so that the two currents do not interfere with each other. When the current returns to the generator, it is compared to the patient's baseline level, which was calculated when the dispersive electrode was first applied. Use of this technology can detect system failures before an injury results.

#### Active Electrode (Pencil, Forceps)

Another type of injury from electrosurgery is unintentional tissue damage at the surgical site or at the site where the tip of the active electrode contacts tissue. Active electrode burns can occur when using excessive power settings. This can cause thermal damage to tissue adjacent to the treatment site. Burns can also occur if the active electrode is left unattended on the patient and is unintentionally activated. Well-insulated safety holsters are recommended when the active electrode is not in use. Folded towels and other "makeshift" devices are not recommended. The use of noninsulated holsters/containers could allow current to flow through the holster to the drapes and ultimately to the patient.

#### Alternate Site

Electrical energy could seek an alternate pathway of return if the connection between the generator and the dispersive electrode is faulty. The current will seek the path to ground that is of the least resistance. The path could be created through the patient's contact with the metal OR bed or through a variety of monitoring sites. The original generators incorporated grounded technology, which assumed that the path of least resistance would be through the patient dispersive electrode. This technology allowed the circuit to be completed either by returning it to ground through the dispersive electrode or through an alternate grounded site.

With the development of isolated generator technology, the potential for alternate site burns has been dramatically reduced. In this isolated system, the generator (not ground) must complete the circuit. This technology has all but eliminated the potential for alternate site burns but does nothing to prevent dispersive pad site burns. Even though the risk is minimal, it is still safest to remove all jewelry and body piercings from the patient.

Alternate site burns also can occur from cracked or broken insulation on the active electrode insulation. Current can leak at the damaged site, and if this area is in contact with either patient or personnel, burns can occur. Active electrode shielding is a safety technology that is becoming more widespread. This prevents leakage of electrical energy from compromised insulation.

Surgeons and assistants can receive burns and shocks during routine electrosurgery, even when they are wearing protective gloves. One reason this occurs is due to a preexisting hole in the glove. The reverse can happen during "buzzing" of a hemostat. In this scenario, the surgeon clamps a bleeding vessel with a hemostat. The hemostat is held, and the electrosurgical current is applied by touching the hemostat with the active electrode, and the tissue between the clamped hemostat is coagulated. This "buzzing" can cause high-voltage breakdown of the glove and create a small hole, allowing current to enter and shock or burn the wearer. Some measures to reduce this risk include

- holding the hemostat firmly over a large area to reduce concentration of charge in a small contact area;
- changing wet gloves before using electrosurgery (gloves show low resistance when they are hydrated);
- making contact between the active electrode and the hemostat before activating the electrosurgical unit;
- periodically inspecting glove integrity for existing holes; and
- using the cut mode because cut uses a lower voltage.

#### Fires

The risk of fire from an electrosurgical spark is one of the greatest hazards because of the potential outcome. Electrosurgical units (ESUs) do not need the presence of flammable anesthetics to ignite. Be sure to tent drapes to allow anesthetics gases and oxygen to dissipate.

Most alcohol-based surgical preps have been eliminated from OR use because of the risk of fire. Nonetheless, nurses must prevent prep solutions from pooling around the operative site. Allow prep solutions to dry and fumes to evaporate before applying drapes.

Draped materials around the operative site could ignite from an electrosurgical spark. This is all the more reason to place the active electrode in an insulated safety holster when not in use.

When using electrosurgery around or near hair, coat the hair with a water-based lubricant such as K-Y Jelly. The lubricant renders the hair fire-resistant. Patients should refrain from using petroleum-based moisturizers or lip balm prior to surgery.

Keep the tip of the active electrode clean and free of char and gross tissue. This minimizes the risk of flaming.

By adhering to strict protocol, the perioperative nurse can help minimize the risk of a fire occurring due to improper use of electrosurgical equipment. Additional safety precautions from AORN's 2006 *Standards, Recommended Practices, and Guidelines* include

- securely mounting the ESU on a shelf or tip-resistant cart;
- ensuring that all safety/warning lights and audible activation indicators are operational at all times;
- never placing fluids on the ESU;
- confirming power settings before activation;
- securing the active electrode to the drapes with plastic or other nonconductive material;
- never using the ESU in the presence of flammable agents, including the vapors from skin prep solutions, tinctures, or defatting agents, etc., or in an oxygen-enriched environment; and

- placing the active electrode in a clean, dry, well-insulated safety holster when not in use.

#### Special Precautions – Patients with Pacemakers, ICDs, etc.

Special precautions must be taken when using ESUs on patients who have pacemakers, internal cardioverter-defibrillators (ICDs), or any other electrical implant.

Electrosurgery can interfere with a pacemaker's circuitry and functioning or create artifact. You should check with the pacemaker manufacturer or the cardiologist about use of electrosurgery. The pacemaker may need to be reprogrammed before and after surgery. Be sure to have a defibrillator immediately available during surgery.

In addition to the precautions listed above, patients with an ICD need special care during electrosurgery. A pre-operative cardiology consult is strongly recommended. The ICD needs to be deactivated during electrosurgical use, or the patient may receive an electrical shock. Place the dispersive pad as close to the operative site (and as far away from the ICD) as possible. If at all possible, using bipolar electrosurgery is a much better alternative.

Patients with other electrical implants, such as bone growth stimulators, cochlear implants, or mechanical drug pumps, should have these devices checked for proper functioning immediately postoperatively. Bipolar electrosurgery is also recommended for these patients.

#### ARGON BEAM ELECTROSURGERY

In recent years argon gas has been found to enhance the coagulation effects of conventional radio frequency (RF) electrosurgery during specific procedures. The argon beam coagulator (ABC) conducts RF current to tissue in a stream of inert argon gas rather than air. The argon gas serves as an electrical bridge between the electrode and the tissue, allowing for a more precise, efficient, noncontact coagulation method.

Coaxial argon gas improves visibility of the surgical field by gently blowing blood and fluids away from the surface. Since it is an inert gas, argon is noncombustible and does not support combustion. It is colorless, odorless,

inexpensive, clears the body in one respiratory cycle, and can pass through inert porous materials. Since argon is heavier than air, it displaces the oxygen and nitrogen in the space between the tissue and electrode, resulting in less carbonization of tissue. Less smoke and odor are produced. The gas also cools the electrode tip and, when used in a contact cut mode, helps reduce eschar buildup on the electrode.

Unlike the gas embolism risk associated with the use of argon lasers, the ABC automatically operates on a low-flow rate. (Flow rates can be adjusted, however.) Gas embolism risk is further reduced because vessels are sealed (coagulated) before enough gas can enter the venous system. Additional safety measures that the perioperative nurse can employ to prevent gas embolism are

- keeping the flow rate at the lowest possible setting;
- purging air from the gas line prior to use; and
- periodically purging air from the line between activations.

Argon beam electrosurgery has been most effective during procedures in which there is potential for diffuse superficial bleeding and constant visualization of the field is essential.

### VESSEL-SEALING DEVICES

Vessel-sealing devices are forms of bipolar electrosurgery that use a combination of pressure and heat to permanently occlude vessels. They are used in both open and laparoscopic surgery. The advantage of this type of electrosurgery is that a reliable seal is produced in a minimal amount of time with minimal thermal spread and resultant tissue destruction.

### ULTRASONIC ELECTROSURGICAL DEVICES

Another new technological advance, the ultrasonic electrosurgical device has a generator that produces electrical energy that is sent to the handpiece, where it is converted into mechanical energy. The resulting energy is sent through a handpiece to a blade or probe that is used for sharp or blunt dissection or coagulation, without damage to adjacent tissues. There is an increased safety

factor with this type of electrosurgery because no electrical current enters the tissue or needs to be returned to the generator. No dispersive electrode is needed.

### ELECTROSURGERY DURING MINIMALLY INVASIVE SURGICAL PROCEDURES

Minimally invasive surgery (MIS) has become a standard alternative for many surgical procedures. This technique has enhanced patient outcomes, as well as increased patient satisfaction. It has, however, caused concern over the potential risks associated with monopolar electrosurgical use in a “closed” space (eg, laparoscopy vs. laparotomy). These risks are not as apparent during “open” laparotomy because the operative field is more visible and because the active electrode is not inserted through a hollow tube (eg, scope, cannula, trocar).

The expected outcome during use of electrosurgical equipment is that the entire radio frequency current will flow to the tip of the active electrode at the intended treatment site. There are circumstances in which the current can flow to unintended sites and cause significant tissue burns. Three added electrosurgical risks related to the active electrode are insulation failure, direct coupling, and capacitive coupling.

**Insulation failure** breaks occur after repeated electrode processing, use, or mishandling. A break or crack in insulation can create an alternate pathway by which the current can escape to adjacent tissue. The smaller the crack, the greater the potential for tissue damage because of the current’s concentration at the alternate site. If this occurs outside the area of visualization, burns can go undetected. If the affected tissue is bowel, severe consequences can result from postoperative peritonitis. The use of disposable electrodes does not necessarily eliminate this problem. Insulation can still become defective during repeated insertion into, and removal from, trocars and cannulae. It is imperative that the perioperative nurse thoroughly inspect active electrodes before, during, and after each use.

**Direct current coupling** occurs when the active electrode comes into contact with another metal object.

Current flows from the active electrode through the metal object (eg, instrument, scope) to adjacent tissue. As with insulation failure, severe burns can occur.

If the metal object is a laparoscope, it can become electrified and cause thermal injury. Again, this can occur out of sight and remain undetected until post-operative complications arise. If the current travels through the laparoscope to the abdominal wall without touching other tissue, it is less likely to result in injury, provided that the abdominal wall is of adequate density. The abdominal wall usually encompasses a relatively large surface that can dissipate the current. If, however, the current cannot dissipate throughout the abdominal wall because a plastic sleeve is in use, it will complete its circuit through adjacent tissues. Direct coupling can be avoided only by activating the electrosurgical unit after ensuring the active electrode is not touching or close to another metal object.

**Capacitive coupling** is the third potential risk that can occur during MIS. A capacitor is formed when an insulator separates two conductors. The conductors can be the active electrode and the metal cannula; the insulator can be the insulation around the active electrode. During capacitive coupling, current is induced through the intact insulation on the active electrode to the cannula (eg, trocar, instrument). Capacitance is stored current waiting to find the path of least resistance (to the dispersive electrode) and is created on the metal cannula. Capacitance is increased during high-voltage coagulation. Capacitance develops when the generator is activated before the active electrode contacts tissue, when the cannula is small, and when the metal cannula is isolated from the abdominal wall by a plastic (nonconductive) sleeve (hybrid system). Capacitive coupling is often unavoidable, but the risks can be minimized.

Current produced during capacitive coupling must be safely dispersed. Using an all-metal cannula system allows current to be dissipated throughout the abdominal/thoracic wall. Use of an all-plastic cannula system eliminates capacitive coupling because a capacitor no longer exists (metal electrode + insulation on the

electrode + metal cannula). Use of a hybrid system creates the greatest potential risk and should be avoided.

The only way to help eliminate the risks associated with insulation failure and capacitive coupling is to conduct the stray current away from the surgical site to the dispersive electrode. Use of an active electrode monitoring system provides this ability. The system monitors and actively shields the active electrode. If stray currents are detected from either insulation failure or capacitive coupling, the monitor interrupts the contact quality circuit in the generator and deactivates the generator before an injury occurs. Since the system operates off the contact quality return electrode, it can be used only with compatible generators.

The only way to eliminate all three associated electrosurgical risks (capacitive coupling, insulation failure, and direct coupling) is by using bipolar technology. This is not always efficient or effective practice.

### SAFE MEDICAL DEVICES ACT (SMDA) OF 1990

Public Law 101-629 (SMDA OF 1990) mandates facilities that use medical devices to follow established guidelines for reporting device-related serious illness to, serious injury to, or death of any facility patient. Serious illness or injury is defined as an illness or injury that is

- life-threatening;
- results in permanent impairment of a bodily function or permanent damage to a bodily structure; or
- necessitates immediate medical or surgical intervention to preclude permanent impairment of a bodily function or permanent damage to a bodily structure.

Medical devices are defined as any instrument, apparatus, or other articles that are used to prevent, diagnose, mitigate, or treat a disease or to affect the structure or function of the body with the exception of drugs. Examples of medical devices include, but are not limited to, ventilators, monitors, electronic equipment, implants, syringes, and catheters.

According to the Act, any device-related illness or injury must be reported within 10 days of discovery to the manufacturer, if known, or to the FDA if the manufacturer is unknown. If there is reasonable probability that a medical device incident caused or contributed to the death of a facility patient, the incident must be reported to the FDA within 10 days of discovery. If the device manufacturer is known, the report must go to the manufacturer as well.

The facility must also submit a semi-annual (January 1 and July 1) summary of reported incidents to the FDA. The following information must be included in all reports involving product incidents:

- product name;
- serial number;
- model number;
- name and address of device manufacturer; and
- brief description of the event.

Each facility is responsible for establishing individual protocols for reporting medical device incidents. Such protocols should involve both risk management and biomedical engineering departments as well as legal counsel.

The electrosurgical generator and associated accessories are primary examples of medical devices that have the potential to cause patient injury in the perioperative arena. It is imperative that all perioperative nurses understand their responsibilities if an incident occurs and are able to comply accordingly.

### **SURGICAL SMOKE PLUME**

Surgical smoke is a byproduct of tissue heating and vaporization of cellular fluid. Smoke plume generated by electrosurgery contains toxic gases and vapors, such as benzene, hydrogen cyanide, and formaldehyde, in addition to blood fragments and viruses. Side effects of high concentrations of smoke plume include ocular and upper respiratory tract irritation. The National Institute for Occupational Safety and Health (NIOSH) recommends that smoke evacuation systems be used to reduce potential acute and chronic health risks to both

patients and health care personnel. The Occupational Safety and Health Administration (OSHA) also addresses safety hazards related to surgical smoke. The use of smoke evacuation systems is highly recommended. Wall suction with in-line filters is appropriate only if a minimal amount of plume is generated.

### **CONCLUSION**

The ongoing evolution of electrosurgical equipment and alternative devices mandates a parallel ongoing demonstration of competent use by all members of the surgical team. Although the use of electrosurgery has become a daily routine for the perioperative nurse, potential associated risks cannot be underestimated. Electrosurgical misadventures are rare, but when they occur, they pose a profound and traumatic event to the patient, the patient's family, and all members of the surgical team, including the perioperative nurse. Delayed wound healing, increased length of hospitalization, infection, and even death can result. Any member of the surgical team may suffer the consequences of expensive litigations and job loss.

Electrosurgery, however, dramatically reduces the morbidity and mortality associated with surgery. It does this by reducing anesthetic time and complications from operative and postoperative hemorrhage. Additionally, many delicate and laparoscopic surgical procedures would be impossible without electrosurgery.

Understanding the basic principles of electrosurgery and electrosurgical equipment can eliminate most of the associated hazards and enhance patient outcomes.

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## POSTTEST

1. **When using bipolar delivery of electrical current, the nurse should remember that**
  - a. the dispersive pad is used to return the current to the generator.
  - b. the dispersive pad should be placed as close to the surgical site as possible.
  - c. one side of the bipolar forceps returns the current to the generator.
2. **During cardiothoracic surgery, the most appropriate person to control the electro-surgical foot pedal when in use is**
  - a. the fellow/chief resident.
  - b. the person using the active electrode.
  - c. the attending surgeon.
3. **If two electro-surgical pencils are needed for the same surgical procedure, the perioperative nurse's best choice is to**
  - a. use one generator as long as current flows through only one pencil at a time, two active electrodes, and a dispersive pad.
  - b. use one ground-referenced and one isolated generator, two pencils, and two dispersive pads.
  - c. use two isolated generators, two active electrodes, and a dispersive pad.
4. **Electrocautery is often used during surgery because**
  - a. it induces chemical bonding of vessels.
  - b. it thermally seals vessels without radio frequency current.
  - c. it provides a safer, more effective way to coagulate surface bleeding.
5. **If a dispersive electrode pad becomes wet during the patient prep, it should be**
  - a. dried thoroughly and protected from further moisture.
  - b. replaced immediately before the patient is draped.
  - c. removed and relocated to an area that will not be affected by moisture.
6. **The dispersive electrode pad is best placed after final patient positioning because**
  - a. skin assessment is most accurately accomplished after the patient is in the final surgical position.
  - b. pad size is best determined when the surgical site is exposed.
  - c. there is less chance that the dispersive electrode will become detached.
7. **Evacuation of surgical smoke during electro-surgery is recommended whenever**
  - a. radio frequency current is used for hemostasis.
  - b. high-frequency electrical current is used to coagulate multiple vessels.
  - c. a blend of cutting and coagulation is selected for hemostasis.
8. **Three determinants of a tissue's response to electro-surgical current are**
  - a. the wave form selected on the generator, the tissue's perfusion status, and the amount of time the tissue is exposed to the current.
  - b. the amount of time the tissue is exposed to the current, the tissue's perfusion status, and the amount of muscle mass at the treatment site.
  - c. the amount of time the tissue is exposed to the current, how high the generator's power is set, and whether cut or coagulate is selected.
9. **To prevent an electro-surgery related fire, the perioperative nurse should**
  - a. periodically clean charred tissue from the surgical site.
  - b. know the location of the closest fire extinguisher and be able to use it.
  - c. place the active electrode in an appropriate safety holster when not in use.

10. **Alternate pathways for electro-surgical current to escape include**
  - a. lithotomy stirrups, ECG electrodes, and EEG electrodes.
  - b. EEG electrodes, OR table extension, and padded armboard.
  - c. padded armboard, seat belt, and ECG electrodes.
11. **Which one of the following tissues offers the most resistance to electro-surgical current?**
  - a. Skin
  - b. Muscle
  - c. Fat
12. **According to ECRI, most electro-surgical injuries occur**
  - a. at the treatment site because of faulty electrical equipment.
  - b. at the treatment site because of unintentional activation of the active electrode.
  - c. at the dispersive electrode pad site because of patient pad compromise.
13. **Dispersive electrode burns can be prevented by using**
  - a. an active electrode monitoring system.
  - b. an isolated electro-surgical system.
  - c. a return-electrode, contact-quality monitoring system.
14. **To minimize the risk of high-voltage glove breakdown during electro-surgery, surgical team members should**
  - a. double glove and change the outer pair of gloves if they are wet before using electro-surgical equipment.
  - b. double glove before using the active electrode to "buzz" a hemostat.
  - c. change wet gloves before using the active electrode.
15. **Active electrode burns can occur when current travels from a break in an instrument's insulation through a metal object it is contacting. This is called**
  - a. capacitive coupling.
  - b. thermal coupling.
  - c. direct coupling.
16. **Capacitive coupling during minimally invasive surgery can be eliminated most effectively with**
  - a. use of an all-plastic cannula/trocar system.
  - b. use of an all-metal cannula/trocar system.
  - c. use of a bipolar electro-surgical system.
17. **Argon gas can be used with conventional electro-surgery to**
  - a. enhance coagulation effects through use of additional argon laser technology.
  - b. enhance electro-surgical precision through the formation of an electrical bridge between the active electrode and tissue.
  - c. enhance the electro-surgical effects on larger vessels during major bleeding.
18. **According to the Safe Medical Devices Act of 1990, any patient injury resulting from electro-surgical use must be reported to**
  - a. the facility risk manager and the OR manager.
  - b. the manufacturer of the electro-surgical unit and accessories, if known, or the FDA if the manufacturer is unknown.
  - c. the facility risk manager and the biomedical engineering department.
19. **During the use of the cutting waveform, targeted tissues are affected by the principle of cellular**
  - a. implosion.
  - b. vaporization.
  - c. dispersion.
20. **Electrocution is not a risk associated with routine electro-surgery because**
  - a. the electro-surgical unit operates on high-frequency alternating current.
  - b. the electro-surgical unit uses direct current, which is of relatively low frequency.
  - c. high-frequency current causes tissue depolarization, which blocks excess current from entering the tissue.

Electrosurgery: Function, Practice and Safety  
Answer Sheet

Question	Answer
1	C
2	B
3	A
4	B
5	B
6	C
7	A
8	C
9	C
10	A
11	A
12	C
13	C
14	C
15	C
16	A
17	B
18	B
19	B
20	A