Electrosurgical Safety: Dangerously Overlooked

ARTICLE BY FRED CARLILE, CST/CFA

In the ever-changing world of medicine, job duties are becoming more specialized; as a consequence, the concept of "teamwork" may seem obsolete. However, one area in health care continues to demand a sense of cohesiveness among its professionals: patient safety.

Those of us who work in the operating room comprise an "OR team." Webster defines team as "a number of persons associated in a joint action or endeavor."[1] The collective effort on the part of the operating room team is directed toward providing the surgical patient (who, because of the effects of anesthesia, preoperative medications, or the gravity of his/her condition, often is rendered totally dependent) with the safest possible surgical experience in which an optimal outcome is the goal. In this effort, operating room personnel are confronted with multiple factors having the potential to threaten patient safety: one area in particular whose importance may be overlooked is electrosurgical safety. Each member of the surgical team, whether a physician, CST, RN, or LPN, should undergo thorough training in the correct use of an electrosurgical unit (ESU).

History

Investigators began studying the tissue-heating properties of radiofrequency currents in the 1890s. These early studies employed Tesla coil resonators (air-core transformers used as a source of high-frequency power) to produce recurrent pulses of damped oscillations described as a restricted (modulated) waveform. By 1925, such technology proved useful in achieving coagulation of tissues. With the introduction of the electronic vacuum tube in the late 1920s, the resulting undamped current (or unrestricted waveform) enabled the electrosurgical cutting of tissues to be performed (Figure 1).[2]

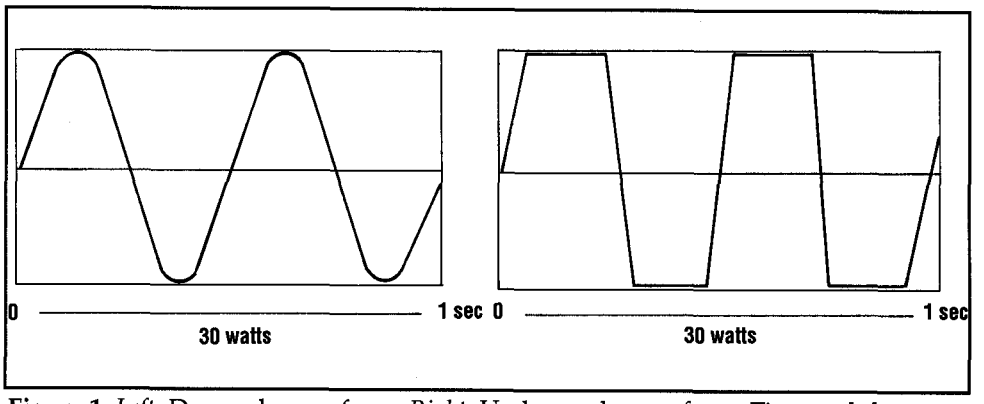

Figure 1. *Left,* Damped wave form. *Right,* Undamped wave form. Time and the power reached remain the same for both, but undamped has sharper form.

In the ensuing years, many improvements were made to these early generators, and today, the ESU is one of the most widely used pieces of equipment in the surgical setting. However, the potential benefits of the ESU may be overshadowed by incorrect use: the improper interconnection of the active and dispersive electrodes with the unit itself can cause injury to the patient. The correct application of these connections is so critical to patient safety that modern units are supplied with a patient-grounding circuit and alarm. The "return electrode monitor" (REM) system constantly monitors the patient return pad by comparing the resistance of the return electrode site to a predetermined range of between 5 and 135 ohms. The system not only recognizes an acceptable range that accommodates small variations in resistance that might otherwise trigger false alarms, but also adapts to the individual patient by measuring the initial contact resistance between the patient and the return electrode. When the unit detects resistance change beyond acceptable perimeters, an alarm sounds and the generator ceases producing output power.[3] Caution must be maintained, however, since skin burns are still possible either because of pad tenting or the pooling of liquids around the pad edges. The rule is to never depend exclusively on the REM system for ensuring patient safety: visual checks are a required element in the protocol.

The primary indication that a pad is not functioning at peak performance is a decrease in the handpiece (bovie) output. A surgeon's sudden request for an increase in the power settings serves to alert the surgical team that a problem with the system connections may have arisen. At this point, a visual check must be made to ensure that adequate contact between the patient and return electrode exists.[2]

Proper use of electrosurgical equipment is essential to patient safety. In recognizing its importance, the Association of Operating Room Nurses (AORN) includes a section entitled "Recommended Practices for Electrosurgery" in its *1996 Standards & Recommended Practices* (Table 1).[4] All surgical team members are strongly encouraged to familiarize themselves with the content of this section; a copy of the *Standards* should be made available in all applicable operating rooms and be accessible through the hospital's

Table 1. Recommended Practices for Electrosurgery*

Recommended Practice I: The electrosurgical unit (ESU), dispersive electrode, and active electrode selected for use should meet performance and safety criteria established by the practice setting.

Recommended Practice II: Perioperative personnel should demonstrate competency in the use of the ESU in the practice setting.

Recommended Practice III: The ESU, active electrode, and dispersive electrode should be used in a manner that reduces the potential for injury.

Recommended Practice IV: Patients and perioperative personnel should be protected from inhaling the smoke generated during electrosurgery.

Recommended Practice V: Policies and procedures for electrosurgery should be developed, reviewed annually, revised as necessary, and available within the practice setting.

medical library.

Serving as a detailed reference, a copy of the manufacturer's operating instructions (users' guide) must accompany each ESU; in addition, a concise "quick-reference" set of instructions may be attached to the unit.[4] Each clinical setting should establish policies and procedures for the safe operation of the ESU that are reviewed and updated annually. All staff members must be familiar with these policies and be apprised of any changes made to them. Once established, these guidelines should be included in the orientation of all new staff members as well as in the ongoing education of all operating room personnel.[4]

Ideally, these operational procedures are devised to address three main topics: those pertaining to actions taken (1) prior to the patient's arrival in the surgical suite; (2) following patient arrival; (3) during the conduct of the procedure; and (4) upon completion of the procedure.

An example of the content of such guidelines follows; these are best presented in an outline format to facilitate their use by operating room personnel. Keep in mind that individual steps (as well as the format in which they are featured) will differ between institutions based on the type of equipment in place and the nature of the practice setting involved. In the following outline, explanatory paragraphs are inserted, although this would not be the case in the set of guidelines developed for actual use in the surgical setting.

A. Prior to Patient Arrival

Surgical personnel first ascertain that an ESU is present in the room and consult the surgical schedule to determine if the procedure requires a foot pedal to be added to the unit.

1. If required in the procedure, a foot pedal is attached to the unit.
2. If pooling of fluids may occur during the procedure, the foot pedal will need to be covered with a clear plastic bag.
3. All necessary adapters are made available.
4. All cords and cables are inspected for cuts or frayed ends.

B. Following Patient Arrival

Return-pad placement involves ensuring that good contact exists between the patient's skin and the pad.

1. Placement of the pad is as close to the operative site as is practical while avoiding the following areas:
   (a) Bony prominence
   (b) Hairy surfaces
   (c) Scar tissue
   (d) Pressure points
   (e) Preexisting skin lesions
   (f) Metallic implants and pacemakers.

Explanation: A metallic implant that is in close proximity to the pad site may serve to concentrate electrosurgical current, resulting in superheating of the surrounding tissues.[4] Additionally, in patients carrying an internal or external pacemaker, the use of an ESU may interrupt the synchronous mode of the pacemaker or block its effectiveness entirely. For such patients, bipolar forceps should be used whenever possible. The bipolar forceps incorporate the active and return electrodes in a single instrument, thus eliminating the need for a separate return electrode (grounding pad) placed on the patient: the bipolar mechanism allows the current to flow from the "active" side of the instrument, passing only through the tissue grasped by the forceps and returning to the ESU via the "return" side of the instrument (Figure 2 p18). If a monopolar circuit must be used, the active and return electrodes are placed as far away from the pacemaker as possible and the distance between the electrodes themselves should be as narrow as can be arranged.[4]

2. Patients carrying an automatic implantable cardioverter defibrillator (AICD) must have such devices deactivated before the procedure is begun and be closely monitored throughout the duration of the procedure: the danger is that ESU current may cause an activated AICD device to shock.[4]
3. Pre-gelled pads are checked for adequate gel and any evidence of drying: if gel is dried, do not use the pads.
4. Prepping agents are not allowed to pool around or underneath the pad.
5. Placement of the pad is arranged to prevent tension between the cable and the unit.
6. Cables are placed so that team members can avoid stepping on or trip ping over them.
7. All jewelry and metal objects worn by the patient must be removed.
   (a) If such removal is not possible, these items should be covered with tape to prevent them from coming into contact with any metal object that may result in "grounding" the patient, causing a burn.
8. Any instance of skin-to-skin contact (such as the patient's arm touching the side of his/her body, or fingers touching the leg) is avoided when positioning the patient; this is accomplished by separating these contact areas with dry towels, sheets, or gauze.[3]

Explanation: Such contact sites are susceptible to burns because in searching for a path to the patient return electrode, the electrosurgical current would pass through a skin-to-skin contact site,

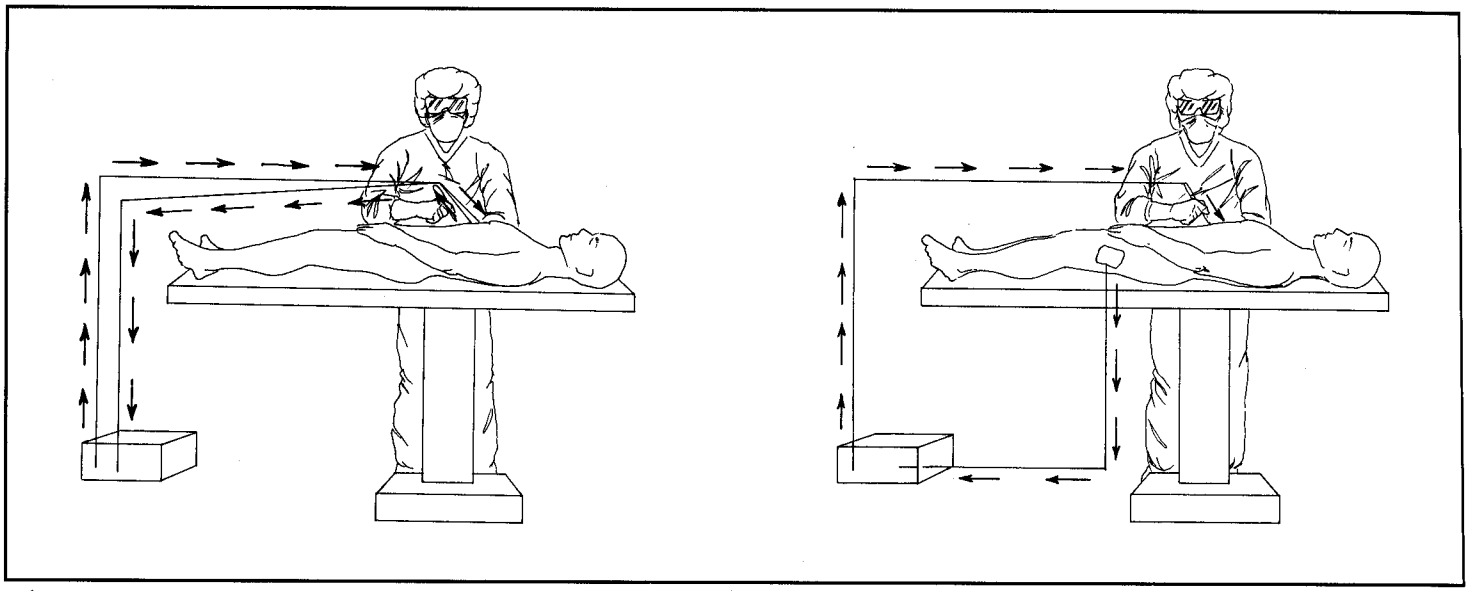

Figure 2. *Left,* Bipolar current flow. *Right,* Monopolar current flow

thus concentrating the current and causing a burn.[3]

C. Connecting the Equipment

Prior to connecting the pad cable to the unit, the unit must first be turned on in order to check the REM system: the alarm should sound (some models feature a red light that signals the presence of a problem).

1. Plug the cable into the unit; an alarm and/or light will activate, indicating that the circuit is now complete. (Again, the features of different models vary.)
2. If the alarm continues to sound, check the pad's location to ensure proper adherence.
   (a) The removal of the pad and shaving of the area may be necessary.
   (b) An alternative action is to select a new site and apply a new pad.
3. If the alarm still does not reset, the unit must be removed from service for inspection by the biomedical department.
4. In connecting the handpiece, the cords passing from the field should not be allowed to pass through the handles of metal clamps or to come in contact with other metal objects.[3]

Explanation: Leakage of electrical current from the cords can be further conducted through such metallic items, potentially causing fires, shocks, or injury to patients and operating room staff.[3] Instead, use the flaps on the disposable drapes, or gather the drape and run the cord through the gather, which is then towel-clipped.

5. Never use a cord that appears to be damaged.
6. Handpieces should not be placed on the field where they may be activated unintentionally.
7. Be aware of the proper method of connecting the accessory to the unit.
8. Use the lowest power settings possible that still provide satisfactory results.
9. The power settings selected for a given procedure must be confirmed verbally between the circulator and the surgeon before activation.
10. The volume of the tone (buzzing) that the unit emits indicating that the bovie is activated must never be lowered to such a degree that it is inaudible.

Explanation: This tone alerts personnel of an accidental activation of the unit. As a precaution, many of the newer units are designed so that the activation tone's volume can not be lowered.

D. During the Procedure

If the pad cord is tugged in any way, either by being stepped on by a team member or because of other circumstances, the pad should be checked visually; do not depend on the alarm system to detect this occurrence.

1. If the patient is repositioned at any time during the procedure, the pad-site must be checked for possible displacement.
2. If alcohol or any other flammable agent is used for prepping, be certain that the prepped area is dry before using the handpiece.
3. Prevent the unit's being used as a table, if possible, and keep the foot pedal dry at all times.
4. If the surgeon asks a team member to "buzz" (cauterize) the hemostat (or forceps), the cauterizing tip of the handpiece must be in contact with the clamp prior to activation of the hand piece because of the potential for arch ing of the electrical current.
   (a) The point of contact should, if at all possible, take place at a level inferior to that of the surgeon's hand.
   (b) Always ensure that no contact occurs between the patient's skin and the clamp prior to handpiece activation.
   (c) Ideally, the surgeon's gloved hand is kept dry to prevent the possible burning of a hole in the glove, thus causing a burn to his/her hand.

E. Following the Procedure

At the conclusion of the procedure, the pad is removed and the skin at the pad site is examined for signs of burns or irritation.

1. The surface of any body part (such as arms, feet, or hands) that may have come in contact with grounded metal

should also be checked.
2. Any sites on which EKG pads were attached are inspected, since the pads potentially serve as a return path for current.
3. Temperature probe sites, which are known to receive burns, are checked.
4. Any other areas suspicious for having received injury are treated, the incident is reported through proper channels, and its occurrence is noted on the patient's chart.
5. If an ESU has caused a burn or other injury, the unit must be taken out of service for inspection by the biomedical department, following which a full report is made.
6. Following those surgical procedures that were conducted without incident, all single-use items are discarded according to hospital policy, and reusable items are either terminally cleaned, inspected, and stored, or resterilized.

Explanation: Appropriate reporting procedures include notifying (by report) the manufacturer as well as the Food and Drug Administration of the unit's failure and resulting patient injury; such procedures are mandated in The Safe Medical Devices Act of 1990.[5] The process of reporting as well as the designation of personnel responsible for its completion are governed by hospital policy. For investigative purposes, all active and dispersive electrodes from the faulty unit (along with their packages) are also retained.

Conclusion

As members of the operating room team, surgical technologists must strive to keep abreast of the myriad changes occurring in health care delivery, an evolution that consists of innovations in procedures, introduction of new equipment and products, advances in technology, and emergence of unprecedented job opportunities. Although faced with this dazzling array of options, we must never lose sight of the needs of our patients whose safety is paramount in our endeavor to provide high quality health care.

Possessing a good working knowledge of the procedures that govern the safe and proper operation of the ESU allows surgical personnel to incorporate these measures into daily routine. More importantly, the patient receives the ultimate benefit: a safe, accident-free surgical experience. The alert, well-informed surgical technologist provides invaluable assistance in eliminating the majority of electrosurgical injuries that can occur in the operating room. Δ

Fred Carlile, CST/CFA, *is employed as a surgical technologist at Cookeville General Hospital in Cookeville, Tenn. He has worked as a surgical technologist for nine years.*

References

1. Clark CE, Summers LR. *The Living Webster Encyclopedic Dictionary of the English Language.* 1st ed. Chicago, Ill: The English-Language Institute of America; 1972:1007.
2. Battig CG. Electrosurgical burn injuries and their prevention. *JAMA.* 1968;204:1025-1029.
3. Valleylab Inc. *Force FX Electrosurgical Generator User's Guide.* Boulder, Colo: Pfizer Hospital Products Group; 1995.
4. Association of Operating Room Nurses, Inc. Recommended practices for electrosurgery. In: *1996 Standards & Recommended Practices.* Denver, Colo: Association of Operating Room Nurses, Inc; 1996:155-161.
5. *The Safe Medical Devices Act of 1990 and The Medical Device Amendments of 1992.* Washington, DC: US Dept of Health and Human Services publication FDA 93-4243.

Guidelines for Authors

Manuscript Submission

The original manuscript along with two copies is mailed to the attention of the editor at AST headquarters. Photographs and other illustrations are protected by stiff cardboard. Authors will be notified by letter upon receipt of the manuscript.

A cover letter accompanies the submission giving the author's address, home and business telephone numbers, and a brief biography, which may include place of employment and education.

Authors are responsible for the factual accuracy of their material and should carefully review their manuscripts before submission. Material used from other sources must be accompanied by a permission letter from the original author or publisher and be acknowledged with a credit line. Articles accepted for publication become the property of AST and may not be reprinted without the expressed consent of the editor.

Manuscript Preparation

Text: The manuscript is typed double-spaced on 8-1/2 by 11-inch white bond paper with 1-inch margins for editorial queries. The organization is as follows: title page, abstract (brief summary of purpose and conclusions of article), introduction, discussion, acknowledgements, references, and figures. Major headings are centered and subheadings flush with the left margin.

Length: The preferred length is 2,000 to 4,000 words.

Figures: Black and white photographs of professional quality are submitted when appropriate. Artwork should be ready for final reproduction; however, AST will handle professional preparation of line drawings when necessary. All figures are numbered, cited in the text, and accompanied by a short explanatory legend. Do not mark directly on photographs or use staples or paper clips to attach them to pages.

Style: Abbreviations are spelled out at first mention in the text with the abbreviation immediately following in parentheses. Thereafter, the abbreviation is used consistently throughout the text. Generic names for equipment and drugs are preferred whenever possible. When tradenames must be used, they are capitalized. Numbers from one to ten are written out except when used with units of measure. For units of measure and numbers greater than ten, Arabic numerals are used.

References are cited in the text by number and listed at the end of the manuscript in numerical order.

Review Procedure

Each manuscript submitted for publication will be scientifically reviewed for accuracy, appropriateness for the journal's audience, and writing quality. Authors of accepted manuscripts will receive a copy of the edited manuscript for approval prior to publication. The manuscripts will be edited for correct English usage, consistency of terminology, and clarity according to the journal's standards of editorial style.