PA PSRS
Pennsylvania Patient Safety Reporting System

Patient Safety Advisory

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Electrosurgery Safety Issues

An article on electrosurgery and the risk of surgical fires was presented in the September 2004 issue of the *PA-PSRS Patient Safety Advisory*.[1] The article described some of the reasons that surgical fires occur during electrosurgery. This article continues the discussion of surgical fires, but also includes discussions of burns to patients and surgical staff related to the use of electrosurgery. Since the PA-PSRS program began in 2004 we have received approximately 170 reports of surgical fires and burns to patients and staff. In most cases, fires and burns can be significantly reduced or eliminated by instituting and following some basic principles of electrosurgery safety.

Electrosurgery-Related Fires
As stated in the September 2004 *Advisory* article, most surgical fires involve electrosurgery such as an electrosurgical unit (ESU) activated in an oxygen-enriched environment. Fires require three elements:

- An **ignition source** such as an ESU active electrode
- **Oxidizers** such as oxygen, room air (21% O_2), N_2O, or medical compressed air
- **Fuel** such as hair, alcohol, surgical drapes, face masks, and tracheal tubes, and other materials.

Because oxygen is "heavier" than air, it can collect in unexpected places such as under surgical drapes in the head and neck area, creating the potential for fire. Materials that don't readily burn in room air will easily burn in a slightly oxygen-enriched atmosphere. For example, endotracheal tubes burn in 26% O_2.

An electrosurgical fire can occur under a number of scenarios.

A heat source such as an ESU can easily ignite alcohol vapors from alcohol-based prep solutions resulting in a surgical fire and/or skin burn. PA-PSRS presented on this topic in the June 2005 issue of the *PA-PSRS Patient Safety Advisory*.[2] A heat source used at the surgical site can ignite alcohol or alcohol-based prep solutions if the solution is allowed to wick into the patient's hair and linens or pool on the patient's skin. If the patient is draped before the solution is completely dry, alcohol vapors can be trapped under the surgical drapes and channeled to the surgical site.

Two practices that may reduce the risk of fire or burns are:

- Ensuring that the prep solution does not soak into hair or linens – sterile towels can be used to absorb drips and runs during application.
- Ensuring that the prep solution is completely dry prior to draping, which may take a few minutes depending on the amount and location of the solution.

For a more comprehensive list of mitigation practices, please see the June 2005 issue of the *PA-PSRS Patient Safety Advisory*.

Some dry surgical materials can also readily ignite. PA-PSRS has received four reports of ignition of dry surgical sponges and one report of ignition of a dry graft when in contact with the active electrode of the handpiece during activation of the ESU. According to the reports, none of the events resulted in injury to the patients or staff.

This can happen when dry sponges are used to blot or absorb excess blood. Wet sponges can also absorb blood, and they typically will not ignite when in contact with the active electrode of the ESU handpiece. Wetting grafts prior to contact with an active ESU handpiece also reduces the likelihood of fire during electrosurgery.

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Electrosurgery Safety Issues (Continued)

We have also received reports in which flames briefly flashed from the tip of active electrosurgical electrodes during electrosurgery procedures. Flames appearing at the tip of an active electrode is usually due to ignition of tissue debris or other flammable material on the electrode tip, which becomes the fuel source in a fire. Ignition is possible, in part, due to locally elevated oxygen concentrations. The active electrode itself will very rarely burn due to its metal and plastic construction. Though some plastics will burn, most of the plastics used in the manufacture of active electrodes have very high ignition temperatures that can only be reached under certain circumstances such as the presence of another fire or possibly laser energy.

Excessive heating of the electrode tip can cause pieces of tissue to adhere to the electrode surface. Arcing techniques such as "spray" coagulation can generate substantial heat at the tip, leading to tissue sticking to the tip (known as eschar buildup). Eschar buildup can be minimized by choosing the most appropriate ESU mode and by cleaning the tip with an abrasive pad specifically made for that purpose. When possible, avoid using arcing techniques such as spray coagulation during cutting and contact coagulation. Using short ESU activations at minimum power settings to produce the desired tissue effect will minimize excessive heating of the active electrode.[3]

Surgeons sometimes use coagulation techniques (arcing coagulation) for most or all electrosurgery in place of cutting. The high peak voltage of coagulation will cut tissue; however, the effect is not as clean and the process is not as safe as using a cutting technique. When using arcing coagulation (a non-contact technique) as a contact technique, charring can develop with eschar buildup on the active electrode tip. This buildup can tear the tissue, causing rebleeding, when the electrode is lifted from the tissue. Coagulation should only be used when clinically necessary, such as for true non-contact coagulation.

Although a rare source of surgical fires, PA-PSRS has received two reports of flame or fire from the ignition of bone cement during electrosurgery procedures. Bone cement is primarily composed of methyl methacrylate or polymethymethacrylate, which are highly flammable substances. Surgical staff need to be aware of the flammability of bone cement in the presence of electrosurgery or other sources of ignition (e.g., laser energy). Bone cement should be used in highly ventilated areas, and methyl methacrylate vapors should be allowed to sufficiently dissipate prior to ESU activation ESU.

Electrosurgery-Related Burns

One of the most common ways for patients and surgical staff to experience skin burns is from inadvertent activation of an ESU (i.e., activated when not in contact with target tissue). Approximately 56% of all ESU-related events reported to PA-PSRS can be attributed to inadvertent ESU activation. Approximately 14% of those events are the result of not placing the active electrode handpiece in a safety holster between intentional activations. The remaining 42% of reports did not provide enough information to determine the reasons for the inadvertent activations.

A common practice is to place the active electrode handpiece on a flat part of the patient's body, such as the abdomen, between uses. Inadvertent activation can easily occur if a staff member leans over or on the patient and makes contact with handpiece's activation switch. The results can include a burn to the patient or the staff member, or ignition of a drape or other flammable material.

More than half of ESU-related burns and fires are attributable to inadvertent ESU activation. Many of these events could be prevented by using a holster for the ESU when it is not in use.

One of the easiest and most effective ways to avoid inadvertent activation is to place the active electrode handpiece in a safety holster that is provided with each new handpiece. For instruments that are too long for a holster (e.g., laparoscopic electrodes), the instrument can be placed on a table such as a Mayo stand that is nearby but away from the patient.

Making contact between an active electrode and another conductive surgical instrument, whether intentionally or unintentionally, can create a burn. For example, PA-PSRS received a report in which a patient experienced a "discoloration" along the vaginal mucosa where a conductive portion of the vaginal speculum was in contact with the vaginal wall. The reporting facility believed that unintentional contact with the speculum during activation of the ESU caused the discoloration. In some cases, intentional contact is made between an active electrode and a conductive in-

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strument such as a hemostat (a technique called "buzzing the hemostat") in an attempt to control bleeding. In such cases an alternate site burn may occur to the patient if the conductive instrument is also in contact with non-target tissue during ESU activation.

Surgical staff must be aware of other instruments in the vicinity of the active electrode to avoid or reduce the potential for burns. Contacting the active electrode with the conductive instrument prior to ESU activation reduces the likelihood of arcing, thereby reducing the likelihood of an alternate site burn.

PA-PSRS has received four reports involving patients wearing jewelry upon entering the OR. In one report the patient refused to remove two nipple rings prior to an appendectomy. In a second report two finger rings were removed from the patient while in the OR. The third report described a patient who was unable to remove a wedding band, and in the fourth report the surgeon assured the patient that her belly ring could remain in place during a laparoscopic hysterectomy.

Most healthcare facilities have policies against patients wearing jewelry during surgical procedures, especially those involving electrosurgical instruments. Many institutions developed policies for fear of patients being burned on the part of the body where the conductive jewelry is located if electrosurgery is applied.

Jewelry need not be removed to avoid burns during electrosurgery. The risk of an alternate-site burn (i.e., those away from the return electrode site) from the electrical conductivity of jewelry is extremely low. Alternate-site burns are more closely associated with contact between the patient and a grounded conductive object – jewelry does not greatly contribute to that risk. Nevertheless, some healthcare facilities encourage patients to remove jewelry to avoid the possibility of loss or theft.

There is a different reason to remove jewelry or cover it with tape or gauze during electrosurgery: to help prevent any sharp edges of the jewelry from scratching the insulation layer of active electrodes or cables of the ESU. Damage to the insulation layer can lead to an unintentional burn from electric current passing from the damaged site to the patient or staff. Prior to deciding on leaving jewelry in place, consider any potential for swelling, especially finger rings during surgery or recovery.[4]

The information in this article is not comprehensive with respect to electrosurgery-related fires or burns, but it accurately presents some of the most common problems associated with electrosurgery. Certainly, due diligence and a good understanding of the technical aspects of electrosurgery on the part of surgical staff will greatly reduce or eliminate the risk of electrosurgery-related injuries or fires from occurring.

When performing electrosurgery:

- Use extreme caution in oxygen-rich environments, particularly during head and neck surgery.
- Be mindful of flammable objects near the surgical site.
- Use coagulation techniques only when clinically necessary.
- Keep the ESU handpiece in the safety holster between activations.

Notes

1. Pennsylvania Patient Safety Reporting System. Patient Safety Advisory. Electrosurgical units and the risk of surgical fires [online]. Available from the internet: http://www.psa.state.pa.us/psa/lib/psa/advisories/sept_2004_advisory_v1_n3.pdf.

2. Pennsylvania Patient Safety Reporting System. Patient Safety Advisory. Risk of fire from alcohol-based solutions [online]. Available from Internet: http://www.psa.state.pa.us/psa/lib/psa/advisories/june_2005_advisory_v2_n2.pdf.

3. ECRI. Ignition of debris on active electrodes [Hazard Report]. *Health Devices* 1998 Sep-Oct;(27):9-10:367-70.

4. ECRI. Allowing patients to wear jewelry during surgical (and electrosurgical) procedures {Talk to the Specialist}. *Health Devices* 1997 Nov;26(11):441-2.

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The Patient Safety Authority is an independent state agency created by Act 13 of 2002, the Medical Care Availability and Reduction of Error ("Mcare") Act. Consistent with Act 13, ECRI, as contractor for the PA-PSRS program, is issuing this newsletter to advise medical facilities of immediate changes that can be instituted to reduce serious events and incidents. For more information about the PA-PSRS program or the Patient Safety Authority, see the Authority's website at www.psa.state.pa.us.

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