Patient Safety Tip of the Week

September 5, 2017   Another Iatrogenic Burn

It’s been over two years since our last column on iatrogenic burns (aside from surgical fires). In our original column on iatrogenic burns (June 1, 2010 Patient Safety Tip of the Week “Iatrogenic Burns”) we described burns from recently autoclaved instruments, warm compresses, MRI interactions with coiled electrodes or metallic transdermal drug patches or various other foreign bodies, thermal blankets, warming bottles, microwaved objects, alcohol or other substances put on skin, and radiation overdoses.

Then in our October 5, 2010 Patient Safety Tip of the Week “More Iatrogenic Burns” we focused on the issue of inadequate cooling of flash-sterilized items and risks associated with dental handpieces. And in our December 23, 2014 Patient Safety Tip of the Week “Iatrogenic Burns in the News Again” we focused on burns related to warming blankets and the practice of “**hosing**” or “**free-hosing**”. Our March 2015 What's New in the Patient Safety World column “Another Source of Iatrogenic Burns” discussed an unusual case of a burn related to halogen lights in the OR. And several of our columns on surgical fires have mentioned other light sources as heat producers.

The most recent release of Statements of Deficiency/Plans of Correction by the CDPH (California Department of Public Health) included a case of an iatrogenic burn. In that case (CDPH 2017) a patient underwent bilateral knee replacement surgery. Left calf blistering was noted post-op that evolved into a full-thickness thermal injury, requiring extensive wound treatments, and it was related to the electrocautery device that had been set down on the patient without holstering it. The bi-polar cautery device handpiece was part of the Aquamantys System. Interview with one of the OR techs indicated that when he entered the OR room he "saw more steam than usual" and saw the electrocautery device under the patient’s leg. He yelled “Stop” and removed the device.

The facility’s plan of correction included re-training to the Operating Room staff on the proper use of the equipment. Training included the proper placement of the wand when not in use and maintaining the alarm volume at an audible setting. The manufacturer at the time apparently did not have an attachment holder for the wand so the facility designed its own mechanism for placement of the wand when not in use.

In some of our previous columns on iatrogenic burns we’ve noted other pieces of hot equipment, such as recently flash sterilized instruments that had not adequately cooled, inadvertently placed on the drapes over a patient have led to burns.

While we have often discussed the role of electrocautery devices in creating surgical fires in oxygen-rich environments (see our numerous columns on surgical fires listed below), Mundinger et al. (Mundinger 2007) noted that intraoperative electrocautery burns can be divided into at least 4 other categories:

1. direct contact burns resulting from inappropriate operator use of the active electrode
2. burns at the grounding electrode site due to improper attachment or placement
3. burns resulting from electrode heating of pooled solutions
4. burns occurring outside the operative field as a result of circuits generated between the active electrode and an alternate grounding source

The current CDPH case is an example of a direct contact burn related to failure to holster the electrocautery device and subsequent contact with a patient's skin. Burns more commonly can develop related to current flow when monopolar electrocautery devices are used. Saaiq et al. (Saaiq 2012) reported on 3 cases of full-thickness deep burns related to the grounding pad of electrocautery systems. All 3 of their cases involved use of monopolar cautery and improper placement of the grounding electrode. The authors note that when the grounding pad is misapplied and loose, this may cause heat generation and sparking at the contact site, without providing an appropriate exit for the current to pass safely through the circuit. Saaiq et al. had the following recommendations:

- The surgeon himself should have a proactive attitude and personally ensure that the grounding pad is adequately applied with firm contact to the skin over an adequate surface area
- Preferably it should be secured to the skin with a crepe bandage
- An area of at least 70 cm^2 of firm skin-pad contact should be ensured
- Special care should be exercised to re-check the position of the pad if the patient's position is changed intraoperatively
- One may employ the newer grounding pads with adhesive properties that firmly attach them to skin
- The diathermy machine's active alarm system will also help to limit the extent of the resultant burn injury
- If a bipolar cautery is employed the risk of grounding pad burns can be eliminated altogether

The authors also note that the electrical current can also run between the active electrode and an alternate grounding source. They note the case described by Mundinger et al. (Mundinger 2007) in which a patient had the grounding pad on her lateral thigh but burns occurred on her forehead related to titanium plates previously implanted in her skull. Mundinger et al. also noted that burns resulting from aberrant circuits have been reported at sites of electrocardiographic lead placement, temperature probe insertion, uninsulated surgical table contact with the patient, intra-arterial line placement, motor-evoked potential monitoring electrode placement, and electroencephalogram electrode placement. That's pretty scary! How many people would even consider the potential impact of remote hardware in or on a patient's body?

Mundinger et al. note that similar burns at sites of contact remote from the operative field and the normal grounding pad may occur on areas of uninsulated surgical table contacting the patient, electrocardiographic leads, temperature probe insertion sites, and sites of placement of various other monitoring devices.

Of 6 iatrogenic burns described by Kaya et al. (Kaya 2016), 3 were related to electrocautery devices. The authors discussed the differences between the two types of electrocautery, namely “unipolar” (or “monopolar”) and “bipolar,”. They made the following recommendations:

- The patient should be examined for any metal implants, and any jewelry should be removed.
- The plates to be used must be of suitable size for the surface area and must fully contact the patient’s skin surface.
- The plate must be placed close to the surgery site, on a smooth, hairless, clean, dry, and well-vascularized muscle.
- The plate must be properly placed on the patient before the surgery and should be regularly checked in long-lasting procedures, and measures such as cold compression should be taken in case of temperature increase.
- Cut and burn settings of the cautery are of further importance. Cut and burn settings of the cautery device should be verified prior to the procedure by both the surgeon and the OR team.
- Necessary information should be given to the healthcare staff about the installation and connections of the equipment, proper placement of the cautery plate, monitoring of the plate during the procedure, and aspects that need the attention of the user.

And don’t lose sight of the fact that **thermal injuries related to electrocautery devices can also occur internally during surgery**. Such are well known to structures such as bowel and ureters. Such injuries are often not recognized and result in tissue necrosis and delayed manifestations of symptoms.

Another unusual cause of iatrogenic burns is related to sue of **operating microscopes**. Choudhry et al. (Choudhry 2013) reported on a patient who experienced a burn from an operating microscope during surgery for a brachial plexus birth palsy, did a literature review, and made recommendations on how to avoid such injuries.

Lopez and colleagues (Lopez 2016) reported a burn related to an operating microscope in a 1 year old girl who underwent surgery for a lumbosacral lipoma with associated cord tethering consistent with a diagnosis of lipomyelomeningocele. Lopez and colleagues did a systematic literature review and found that all the clinical cases of iatrogenic microscope burns presented in the literature have involved the use of a xenon-based operating room microscope. Thirteen out of the 15 cases in the literature involved a microscope which is equipped with a xenon light source and 14 out of the 15 cases involved operating microscopes illuminating at 100% intensity. Twelve of the 15 reported cases occurred during otolaryngology procedures. Furthermore, the cases reported in the literature were highly variable in length of procedure ranging from 15 min to over 180 min. Most of the iatrogenic burns resulted in second degree burns with few receiving further surgical management, such as skin grafting.

They then did a search of FDA's MAUDE database and found a total of 60 unique cases of iatrogenic burns associated with operating microscopes reported to the FDA from 2004 to 2013. A disproportionate large number of iatrogenic burns occurred during neurosurgical and otolaryngology procedures compared to other surgical specialties. They found that 25% of cases occurred in procedures that lasted more than 3 h but two cases reported skin burns after procedures that lasted less than 30 min. Approximately a quarter of the cases reported using 100% illumination intensity while only one case reported using less than 50% illumination intensity.

The majority of the reported cases in the literature occurred either in the elderly or the very young. To explain why such events were more frequent during neurosurgical or otolaryngology procedures, they speculated that the sites operated on might be particularly vulnerable to burns due to a thin dermis or minimal underlying adipose tissue such as the ears, scalp, or the mid-back. They also speculated that certain medications (eg. steroids, local anesthetics with or without epinephrine) might predispose to burns. And they note that hyperpigmentation or darker skin may be a risk factor, perhaps due to increased light absorption from the skin. They mention that even pigmentation from the skin disinfectant used might predispose to such burns.

Lopez and colleagues recommended the following best practices to minimize the risk of thermal injuries during procedures using the microscope:

- utilize the lowest illumination intensity
- minimize operative time
- use longer focal lengths
- minimize the use of epinephrine
- frequently irrigate the surgical site
- take special precautions be utilized in elderly and children, especially during neurosurgical and otolaryngology procedures which may often involve surgical skin sites that are more vulnerable to thermal injury

Pabari et al. (Pabari 2007) also noted 2 cases of unusual burns in the OR. One burn of skin on arm during orthopedic surgery related to alcohol skin preparation. Details were not provided. One would wonder whether this might have also been related to mono-polar cautery as we've described above. The other case involved a scalding injury to the perineum related to leak of water heated to 80 degrees C during a hydrothermal ablation of the uterus.

In our June 1, 2010 Patient Safety Tip of the Week "Iatrogenic Burns" we noted there are really 3 key conditions that predispose patients to burns. They are either **insensitive to pain/temperature**, **unresponsive**, or **unable to communicate**. There may be some additional predisposing factors, too, like poor tissue perfusion and impaired ability for the vasculature to help dissipate heat from the skin. And, of course, you need a heat source.

Patients who are obtunded or comatose or who are under anesthesia may not perceive heat or pain or be able to respond even if they could feel it. Patients who cannot communicate (infants, patients with aphasia, patients isolated in MRI suites, etc.) may perceive pain and temperature but may not be able to alert caregivers. And some patient cannot feel heat/pain because of local or regional anesthetic or certain neurological disorders (diabetic neuropathy, some other neuropathies, congenital insensitivity to pain, spinal cord problems, syringomyelia, certain CNS lesions, etc.).

But even patients with normal sensation may get burns under certain circumstances. Has the following ever occurred to you? You test the water temperature before you step into the shower and it feels too hot. You turn the hot water knob down (or turn the cold water knob up) and the water temperature is comfortable enough for you to begin showering. After a few minutes you increase the water temperature. The increased warmth may, in fact, feel good. But when you finish your shower you notice your skin is much redder than you usually experience. What happened? This was **adaptation** to heat (adaptation probably occurs at both the peripheral receptor level and a central level). You were no longer bothered by water at the same temperature that frightened you at the start. Yet that hot water was capable of burning your skin. The same sort of adaptation takes place to cold (ever dive in a 65 degree lake? You shout out "It's freezing!" but after about a minute it becomes more tolerable).

So the point is this: even moderate heat applied for a long duration is capable of producing burns and patients may be surprisingly unaware that the burn is occurring. The potential damage to skin (or other organs) is a **function of both temperature and duration**.

So what should you do in your organization to minimize the risks of iatrogenic burns?

- Do an inventory or survey in your organization to see if you use "warm compresses" or heat therapy (if you have computerized order entry you might be able to find these orders. Otherwise you'll have to just survey nurses and doctors to see if they are ever used at your organization).
- If you find warm compresses are being used, make sure there is a good clinical evidence base to support their use for that particular indication.
- Establish burn risk assessments
  It's not likely to be good use of time doing universal burn risk assessment on admission. Rather, you need to identify in which patients and **when** burn risk assessments should be done. Obviously that would be in any patient in whom use of heat is contemplated. The assessment would include whether the patient has the ability to perceive pain and temperature in the site(s) where heat is to be applied.
- In your neonatal units, make sure you have protocols in place for assessment of temperature of any object that may come into contact with the skin of an infant and any other heat sources (eg. lights) that may be close to the infant.
- If you apply heat, have protocols that require assessment of temperature and specify intervals at which skin assessment must be done.
- In the OR, beware of the burn danger any time a "flashed" piece of equipment is used and have a system to ensure such instruments have adequately cooled before use.

- Better yet, optimize your equipment/instrument inventory and practices so that you don't every need to "flash" sterilize items.
- In the MRI suite, your protocols must include steps to identify any wires or cables that cannot be removed and ensure that there is minimal "coiling" or "looping" of these. Also make sure the patient is not wearing any transdermal drug patches that might contain metal or ferromagnetic components. (But also don't forget after the scan is completed to restore the cables or drug patches.)
- See the recommendations in our December 23, 2014 Patient Safety Tip of the Week "Iatrogenic Burns in the News Again" regarding use of warming devices.
- See the recommendations in our October 5, 2010 Patient Safety Tip of the Week "More Iatrogenic Burns" regarding use of dental handpieces.
- Heed the advice in today's column regarding steps to minimize the risk of burns related to electrocautery devices and operating microscopes.

A point worth reiterating is the fact that burns result not just from the temperature of the heat source but also the **duration**. In several of our columns on the impact of surgical case duration we've recommended all OR's have in place a system where the duration of surgery is formally announced to all participants at regular intervals. That may provide a clue that certain actions may be needed (eg. give a second dose of prophylactic antibiotics, reposition the patient to avoid pressure ulcers or pressure neuropathies, consider intraoperative DVT prophylaxis). Perhaps, given today's warnings about burns related to electrocautery systems or operating microscopes, you might also add checking the grounding pad site or microscope field to such actions.

While burns due to surgical fires are also clearly iatrogenic, we have separated those out in our discussions about iatrogenic burns.

Our prior columns on iatrogenic burns:

- June 1, 2010 "Iatrogenic Burns"
- October 5, 2010 "More Iatrogenic Burns"
- December 23, 2014 "Iatrogenic Burns in the News Again"
- March 2015 "Another Source of Iatrogenic Burns"

Our prior columns on surgical fires:

- December 4, 2007 "Surgical Fires"
- April 29, 2008 "ASA Practice Advisory on Operating Room Fires"
- November 2009 "ECRI: Update to Surgical Fire Prevention"
- January 2011 "Surgical Fires Not Just in High-Risk Cases"
- March 2011 "APSF Fire Safety Video"
- November 2011 "FDA Initiative on Preventing Surgical Fires"
- December 13, 2011 "Surgical Fires Again"
- April 24, 2012 "Fire Hazard of Skin Preps Oxygen"
- April 2013 "Reminder: Hand Sanitizers Are Flammable"
- June 25, 2013 "Update on Surgical Fires"

- October 1, 2013 "Fuels and Oxygen in OR Fires"
- August 12, 2014 "Surgical Fires Back in the News"
- December 16, 2014 "More on Each Element of the Surgical Fire Triad"
- December 2015 "Unique Ignition Sources in Surgical/OR Fires"
- January 10, 2017 "The 26-ml Applicator Strikes Again!"

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