Patient Safety Tip of the Week

December 16, 2014

More on Each Element of the Surgical Fire Triad

In our many columns on surgical fires (see the list at the end of today's column) we've discussed contributions of each of the elements of the "**fire triangle**" (fuel, oxidizer, heat source).

First, the "**fuel**" side of the fire triangle. The Anesthesia Patient Safety Foundation (APSF) has their lead article about flammable surgical preps in the October 2014 issue of the APSF Newsletter (Cowles 2014). We discussed the role of alcohol-based skin preps or other volatile substances in our Patient Safety Tips of the Week for April 24, 2012 "Fire Hazard of Skin Preps, Oxygen", June 25, 2013 "Update on Surgical Fires" and October 1, 2013 "Fuels and Oxygen in OR Fires". But the new APSF article has some nice **tables listing the alcohol content of commonly used skin preps** and alcohol-based hand rubs. It has good advice about the importance of communication in the OR as it pertains to ensuring adequate drying time for surgical preps and assessment for alcohol pooling near the surgical field. It emphasizes that adequate drying time is still important in emergency cases. Our August 12, 2014 Patient Safety Tip of the Week "Surgical Fires Back in the News" described a fire in an emergency case in which there was an inadequate delay for an alcohol-based skin disinfectant to dry and the patient had received 100% oxygen. Subsequently the hospital implemented a policy prohibiting alcohol-based skin preps in any emergency surgery that does not allow sufficient drying time (usually 3 minutes or longer). Instead they have gone back to non-alcohol-based preps like Betadine for such emergency cases.

Another key point in the recent APSF article: "**read the fine print**". The package inserts on the surgical preps often have warnings about fire risk. In several of our prior articles we noted another surgical fire in which a hospital had switched from the 10.5 ml Chloraprep applicator, which did not have the warning to avoid use in head and neck surgery, to the 26 ml applicator which did have the warning. It is actually quite predictable that staff would assume the new supplies were the same as the old and not "read the fine print".

The other "pearl" in the APSF article about alcohol-based surgical preps is that, whereas the drying time for most such preps is typically at least 3 minutes, drying time of **up to 1 hour** may be needed when applied to **hairy areas, body folds, or body creases**.

On to the "**oxidizer**" side of the fire triangle. The December 2014 issue of Outpatient Surgery Magazine has a Q&A session with ECRI Institute's Mark Bruley, considered by many to be the leading authority on OR fires (Burger 2014). Bruley stresses that oxygen is the most important element in most OR fires, noting that only about 5% of OR fires involve alcohol-based surgical preps that are still wet. He notes that the real fire hazards happen when oxygen concentrations get up above 40-50% and that anesthesia providers often gave oxygen freely from open sources in many minor procedures, using 100% regardless of patient needs. He points out that in the rare case where a patient does require oxygen from an open source you should start at 30%. He stresses, however, that the current recommendation is that when a patient does need supplemental oxygen, particularly in high-risk areas (head, neck, face, airway, chest) the patient should have a tracheostomy tube or laryngeal mask to prevent buildup of oxygen around the surgical site.

And lastly, the "**heat source**" side of the fire triangle (though this new information is actually about oxygen). Far and away the two most frequent contributing factors to the majority of OR fires are the oxygen-enriched environment and use of an **electrocautery** device (see below). So William Culp and colleagues have come up with a unique approach to address both (Culp 2014). Using the rationale that we use carbon dioxide (CO_2) to extinguish fires by displacing oxygen, they designed a prototype electrocautery pencil that expresses a cone of CO_2 from its tip when activated so that oxygen is displaced. They tested the device in the lab by seeing how long it took for the device to ignite a laparotomy sponge at different oxygen concentrations with the CO_2 on or off. With it off the sponge ignited in 15/15 trials (all O_2 concentrations) but in 0/15 trials with the CO_2 on. What a great concept!

But the device is not yet ready for prime time. It appears to need some design work to make the device easier to use by surgeons. And we need to be concerned about unexpected or unintended consequences. Perhaps the biggest potential unintended consequence is a phenomena we've pointed out several times, described by Charles Perrow in his classic book "Normal Accidents" (Perrow 1999) where he talks about how new technologies often simply "push the envelope". He cites as an example how the introduction of maritime radar simply encouraged boats to travel faster and did little to reduce the occurrence of maritime accidents. Indeed, the editorial (Feldman 2014) accompanying the Culp study warns about exactly that – the risk that surgeons and anesthesiologists might now consider the fire risk so low that they use oxygen indiscriminately. Feldman et al. also raise the possibility that use of the device could result in hypercarbia when used around the face or airway. And we'll even throw in the possibility the CO_2 source could be expended or malfunction without awareness of the surgeon.

But, given that OR fires continue to occur despite widespread attention, training, inservicing, posters, pre-op huddles, and other efforts, a solution that minimizes the risk of human error would be a most welcome addition. The prototype by Culp and colleagues is thus very exciting.

In our June 25, 2013 Patient Safety Tip of the Week "Update on Surgical Fires" we cited an analysis of closed malpractice claims involving surgical fires (Mehta 2013). That analysis showed that 99% involved procedures known to be high risk for fires (head, neck, or upper chest surgery), electrocautery was the ignition source in 90% of claims, and oxygen was the oxidizer in 95% of claims. Alchohol-containing prep solutions and volatile compounds were identified in only 15% of OR fires during monitored anesthesia care. Importantly, the vast majority of claims were for fires that occurred during monitored anesthesia care rather than general anesthesia. That highlights the importance of oxygen. **In the vast majority of claims involving monitored anesthesia care the oxygen was delivered by an open delivery system**. It really highlights that there has been a trend for surgical/OR fires to be seen more often in relatively minor surgery (eg. plastic procedures removal of skin lesions, temporal artery biopsies, etc.), done under sedation or monitored anesthesia care where there is open delivery of oxygen.

The October 2014 APSF Newsletter also had an update on claims payouts for OR fires (Sanford 2014). It notes that a malpractice insurance company for about 5000 anesthesia providers has handled 42 cases of intraoperative fire since 1990, 31 of which involved the high-risk areas of face, head and neck. Almost every case involved oxygen and electrocautery or laser instruments. It highlights a case in which the victim of an OR fire was awarded an $18 million judgment. In addition to the cognitive aids noted previously, the authors note some facilities are using "**smart anesthesia messages (SAM's)**" via computer to remind the OR staff about high-risk cases. They also mention the APSF fire prevention algorithm that may be quite useful in helping the OR team identify and prepare for appropriate precautions and procedures in those identified at-risk.

We have long advocated that the **surgical fire risk be discussed as part of the pre-op huddle (or pre-op briefing)** and, if the case is considered high-risk, respective roles of all OR participants are called out during the surgical timeout. We've always liked the checklist "The Surgical Fire Assessment Protocol" developed at the San Francisco VA as part of an effort to promote fire safety in the OR (Murphy 2010). The Christiana Care Health System also has some good examples of incorporating the fire risk into Universal Protocol plus many other great tools in their Surgical Fire Risk Assessment resources.

We also can't overemphasize the importance of doing drills for OR fires. Even if we identify high-risk cases there will be others we did not consider to be at high risk. While head, neck and upper chest surgeries have been considered to be at greatest risk for surgical fires, don't forget that they can occur in almost any surgery (see our January 2011 What's New in the Patient Safety World column "Surgical Fires Not Just in High-Risk Cases" and April 24, 2012 Patient Safety Tip of the Week "Fire Hazard of Skin Preps Oxygen" for examples of fires during procedures on other areas of the body).

Therefore, doing drills is important so each member of the OR team know his/her role in responding to an OR fire.

We hope you'll look at the many useful recommendations in our previous columns (listed below). And, of course, we again refer you to the valuable resources on surgical fires provided by ECRI Institute, AORN, the FDA, Christiana Care Health System and the APSF.

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"

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http://www.patientsafety.va.gov/docs/TIPS/TIPS_NovDec10.pdf#page=3

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http://www.christianacare.org/FireRiskAssessment

ECRI Institute. Surgical Fire Prevention.

https://www.ecri.org/surgical_fires

AORN (Association of periOperative Registered Nurses). Fire Safety Tool Kit.
http://www.aorn.org/toolkits/firesafety/

FDA. Preventing Surgical Fires.
http://www.fda.gov/Drugs/DrugSafety/SafeUseInitiative/PreventingSurgicalFires/default.htm

APSF (Anesthesia Patient Safety Foundation). Resources. Fire Safety Video. Prevention And Management Of Operating Room Fires.
http://www.apsf.org/resources/fire-safety/

Healthcare Consulting
www.patientsafetysolutions.com

http://www.patientsafetysolutions.com/

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