

Surgical Fires: Prevention and Safety

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The ECRI Institute estimates that 200 to 240 surgical fires occur annually in the United States, with some of them causing serious injury, disfigurement, and even death.¹ Although surgical fires are uncommon, the frequency of their occurrence is comparable to other surgical safety events, such as wrong-site surgery and unintended foreign object retention.² The resulting consequences can be catastrophic for patients, healthcare providers, and healthcare facilities. Yet, nearly all of these surgical fires are preventable.

Further, the prevalence of surgical fires might be higher than estimates suggest because minor fires, fires that don't cause significant damage, and near-misses sometimes go unreported. Yet, these situations are potentially hazardous. Any fire that occurs inside a surgical setting puts the patient at a potential risk of serious or even fatal injuries.

This article provides an overview of surgical fires and discusses ways that healthcare providers and facilities can take proactive steps to prevent these dangerous occurrences.

Understanding Surgical Fires

Surgical fires, unlike other types of healthcare fires, typically involve an anesthetized patient, which creates an additional complication for healthcare staff. An anesthetized patient lying on an operating room (OR) surgical table is not capable of self-preservation and must rely on the surgical team to protect his/her well-being. Thus, team awareness of where and how surgical fires occur is imperative.

The traditional hospital OR is a primary site for surgical fires, but they also can occur in other locations, such as ambulatory surgery centers and endoscopy suites. Even a physician's office can be the potential site of a surgical fire.

The three main elements of fire – fuels, oxygen, and ignition sources – can be found in any OR setting. Fuel sources inside the surgery suite are everywhere; they include skin preparations, bone adhesives, aerosols, ointments, surgical drapes, scrubs, towels, masks, gowns, mattress pads, plastic bags, suction canisters, tubing, sponges, tapes, dressings, gloves, suture supplies, wiring, and airway maintenance devices.

The surgical team must understand that any material or item with a carbon chemical base can be ignited and will burn. Some alcohol-based skin-preparation agents and bone adhesives are extremely flammable, and vapors can pool unnoticed underneath a patient.

Fuel sources also include the patient and patient-related items, such as body hair, fatty tissue, and gastrointestinal gases, such as hydrogen and methane.

Oxygen sources inside the surgery suite include ambient air, medical air, nitrous oxide, and an oxygen-enriched atmosphere. If an oxygen-fed fire occurs in the OR, staff should anticipate a hot, rapidly intensifying, spreading fire. Any fire that involves an oxygen-enriched atmosphere will be difficult to extinguish. Staff should also

Surgical Fire Example: No Harm, No Foul?

A surgeon accidentally stepped on the footswitch of an unholstered laser, which momentarily fired a concentrated beam of light into a surgical drape. The surgeon realized his mistake and moved his foot off the footswitch, but a small circular burn patch had already begun to develop. A surgical technician quickly knocked the drape to the floor, and a circulating nurse doused it with sterile water.

The surgical team responded immediately and appropriately. The patient was anesthetized at the time, nobody was harmed, and the fire was incidental. Later, the team members discussed the incident among themselves, but no one escalated the issue. The team members believed it didn't warrant a report, so the incident did not make it into the hospital's risk management incident reporting system, and it was never reported to the local fire department.

Although no harm occurred, reporting the incident would have provided the team an opportunity to evaluate what happened, identify potential safety concerns, and develop strategies to address them.

understand that nitrous oxide, when subjected to a fire, can liberate oxygen to support combustion.

Typical ignition sources in the surgery suite include electrosurgical units, electrocautery devices, fiberoptic light sources, lasers, defibrillators, high-speed drills, and electrical cords. Some of these devices can produce temperatures in excess of several thousand degrees, which greatly exceeds the normal ignition temperature of most fuel sources. Even after these devices are used, the tip temperature can remain hot enough to ignite surrounding fuel sources.

Some surgical fires last only seconds (i.e., flash fires). Others can grow exponentially – e.g., a spark occurring in an oxygen-enriched atmosphere can grow to a fire in nanoseconds that will challenge even the best-trained surgical staff. Once a fire begins to develop and gain headway, it will be capable of producing hot toxic gases and copious amounts of choking smoke. A growing fire of this magnitude will limit the staff's breathing and visibility. As hot toxic gases and smoke are produced, panic and confusion may ensue.

Fortunately for healthcare providers and patients, most surgical fires can be prevented through education, training, and strategies undertaken to minimize fire risks.

Preventing Surgical Fires

Educate and Train

Most surgical fire education and training is directed at a limited audience – the nursing staff. Although the nursing staff usually controls the fuel sources, other team members might control the other critical elements that can lead to fires. For example, the surgeon typically controls the ignition sources, and the anesthesia provider typically controls the oxygen sources. Also, it is possible that these activities may overlap in a surgical setting.

Thus, one of the best methods for preventing surgical fires is to educate and train every member of the surgical team – e.g., the surgeon, surgical resident, anesthesia provider, scrub nurse, circulating nurse, charge nurse, surgical technician, students, and independent licensed practitioners – about the basic elements that contribute to fire and how best to control them.

The following sections provide strategies for minimizing the risks associated with ignition sources, fuel sources, and oxygen/oxidizer sources – the main elements of fire. Organizations can use these strategies as part of fire prevention educational efforts.

Implement Risk Strategies

Strategies From the Preventing Surgical Fires Initiative

In October 2011, the U.S. Food and Drug Administration (FDA) and its partners launched the Preventing Surgical Fires Initiative to increase awareness of the risks of surgical fires and promote the adoption of risk-reduction practices throughout the healthcare community.

In 2015, The Joint Commission (TJC) took leadership of the Preventing Surgical Fires Initiative, with the Council for Surgical & Perioperative Safety hosting the initiative's webpages and resources. The initiative offers the following recommendations for preventing surgical fires:

- Conduct a fire risk assessment at the beginning of each procedure. The highest risk procedures involve an ignition source, delivery of supplemental oxygen, and the operation of the ignition source near the oxygen (e.g., head, neck, or upper chest surgery).
- Take safety precautions when using supplemental oxygen.
 - Evaluate if supplemental oxygen is needed for each patient. Any increase in oxygen concentration in the surgical field increases the chance of fire.
 - If supplemental oxygen is necessary, particularly for surgery in the head, neck, or upper chest area.
 - Deliver the minimum concentration of oxygen needed to maintain adequate oxygen saturation for your patient.
 - Use a closed oxygen delivery system such as an endotracheal tube or laryngeal mask whenever possible, especially if high concentrations of supplemental oxygen (greater than 30 percent) are being delivered.

- Take additional precautions to exclude oxygen from the field if using an open delivery system. These precautions include draping techniques that avoid accumulation of oxygen in the surgical field, the use of incise or fenestrated drapes that may help isolate oxygen from the surgical site, blowing air to wash out excess oxygen, or alternatively, scavenging oxygen from the field.
- Use alcohol-based (flammable) skin preparation agents safely.
 - Prevent alcohol-based antiseptics from pooling during skin preparation. For example use the appropriate size applicator for the surgical site.
 - Remove alcohol-soaked materials from the prep area.
 - Allow adequate drying time, as prescribed in the labeling, for the specific product. If the product is used on hairy areas or in skin folds, extend the drying time.
 - Ensure the skin is dry before draping the patient and beginning surgery.
- Use devices and other surgical equipment safely.
 - Consider alternatives to using an ignition source for surgery of the head, neck, and upper chest if high concentrations of supplemental oxygen (greater than 30 percent) are being delivered. If an ignition source must be used, it is safer to do so after allowing time for the oxygen concentration to decrease. It may take several minutes for a reduction of oxygen concentration in the area even after stopping the gas or lowering its concentration.
 - When not in use, place ignition sources, such as electrosurgical units and electrocautery devices, in a holster – not on the patient or drapes.
 - Be aware that surgical drapes and other fuel sources can ignite easily and burn in an oxygen-enriched environment, even if the products are described as “flame-resistant.”

- Encourage communication among members of your surgical team.
 - Ensure the anesthesia provider delivering the gases is communicating with the surgeon controlling the ignition source and the clinician applying the skin preparation agent.
- Plan how to manage a surgical fire. For example, understand how to extinguish a fire burning on a patient, develop evacuation procedures, conduct fire drills, and keep saline on hand to put out a fire.³

Other Strategies

In addition to the aforementioned strategies, the following tips also can help surgical teams reduce the risk of OR fires:

- Ensure that any piece of electrically powered equipment or equipment used to supply power is operated in accordance with the manufacturer's recommended operating guidelines.
- Identify a current preventive maintenance sticker on medical equipment prior to use. An additional biomedical engineering calibration sticker might also be on the device, which will indicate the most recent measured output levels.
- Remove from service and appropriately tag any piece of medical equipment that has outdated sticker information, appears to be damaged, doesn't work properly, or is otherwise questionable in the mind of the operator. Do not change or alter any medical device to improve the performance of that device.
- Inspect cables and electrical supply cords in the surgical area before use. If the cable or cord is too short, frayed, cut, or pulled tight, it could pose a potential electrical safety concern.
- Do not turn on medical devices prior to plugging them in to a receptacle. Likewise, do not pull the plug out of a receptacle while a device is still on. Either situation may increase the risk of a fire. If the device is placed on a cart, the cart should be a stable platform not prone to tipping over.

- If a piece of medical equipment begins to emit a burning odor or shows signs of sparking or smoke, immediately unplug the device, remove it from the OR, and call biomedical engineering immediately.
- Operate electrosurgical units and electrocautery devices and lasers at the lowest possible output settings to accomplish the surgery.
- Any time a fiberoptic light source is used, secure it away from the ends of any drape. Turn off fiberoptic light sources when not in use.
- Develop guidelines for patients that address hair care products, facial care products, and makeup. These products often can add to the fuel load. Coat any facial hair near the surgical site with a water soluble surgical jelly to eliminate a potential fuel source.
- Moisten sponges, gauze, and other items that are going to be used in or near the surgical site with saline or sterile water to lessen the chance of ignition. Consider using towels soaked in the same manner.
- Replace oxygen tubing that is leaking as quickly as possible, and shut off oxygen between surgical cases and overnight.
- Handle nitrous oxide with the same precautions as oxygen, as it poses the same hazard.

Additionally, TJC suggests these strategies to help prevent surgical fires:

- Inform staff members, including surgeons and anesthesiologists, about the importance of controlling heat sources by following laser and electrosurgical unit safety practices.
- Manage fuels by allowing sufficient time for patient prep.
- Establish guidelines for minimizing oxygen concentration under the drapes.
- Develop, implement, and test procedures to ensure appropriate response by every member of the surgical team to fires in the OR.
- Report any surgical fires to TJC, ECRI Institute, the FDA, and state agencies, among others, to raise awareness.⁴

Take-Away Message

Although surgical fires are not common, they can have devastating effects on patients, providers, and facilities. To mitigate the risks associated with surgical fires, education, training, and awareness are essential. The surgical team should understand how fires can potentially start in the OR and how to control heat, fuel, and oxygen sources.

Additionally, providers and staff should be aware of the importance of reporting surgical fires and near-misses – even if they do not result in harm – to increase understanding of how these incidents occur and how the team can avoid them. Taking proactive steps to avoid and control fire risks might ultimately prevent a tragedy.

Endnotes

¹ ECRI Institute. (2016, June). Surgical fires. *Healthcare Risk Control*. Retrieved from www.ecri.org/components/HRC/Pages/SafSec13_1.aspx

² ECRI Institute. (n.d.). Surgical fire prevention. Retrieved from www.ecri.org/Accident_Investigation/Pages/Surgical-Fire-Prevention.aspx

³ The Joint Commission. (2015). Recommendations for healthcare professionals on preventing surgical fires. Retrieved from www.cspsteam.org/about-the-preventing-surgical-fires-initiative/?rq=preventing%20surgical%20fires%20initiative

⁴ Pelletier, M. G. (2017). Leading hospital improvement. Retrieved from www.jointcommission.org/the_view_from_the_joint_commission/only_you_can_prevent_surgical_fires/

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