Surgical Fires: Prevention and Safety

Surgical fires are considered uncommon in healthcare, with estimates ranging from approximately 550 to 650 surgical fires each year in the United States. However, the consequences of these fires can be catastrophic for patients, healthcare providers, and healthcare facilities.

Further, the prevalence of surgical fires might be higher than estimates suggest, as minor fires, fires that don’t cause significant damage, and near-misses sometimes go unreported. Yet, these types of situations are potentially hazardous. Any fire that occurs inside a surgical setting puts the patient at 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.

Surgical Fires: What We Know

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

Although the traditional hospital OR is a primary site for surgical fires, 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,

Case Example

A distracted surgeon accidentally steps on the footswitch of an unholstered laser; it activates and momentarily fires a concentrated beam of light into a surgical drape. The surgeon realizes his mistake and slips his foot off of the footswitch, but a small circular burn patch has already begun to develop. The drape is quickly knocked to the floor by the surgical technician and extinguished when the circulating nurse douses it with sterile water.

The surgical team responded immediately and appropriately, the patient was anesthetized at the time, nobody including the patient was harmed, and the fire was incidental. Everybody looks at each other from behind their surgical masks with the same thought: "We have a long schedule today, and nobody else needs to know what just happened."

Later, they might discuss the incident among themselves, but it never gets passed along. They believe it probably doesn’t warrant a report, so it doesn’t make it into the hospital’s risk management incident reporting system, and it certainly doesn’t get reported to the local fire department.
but are not limited to, skin preparations, bone adhesives, aerosols, ointments, drapes, scrubs, 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 skin-prepping agents and bone adhesives are extremely flammable, and vapors can pool unnoticed underneath a patient.

Fuel sources also include 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 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, 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 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, and students — 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-focused education 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.* 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).

- Use supplemental oxygen safely.
  - 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 which may help isolate

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* 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 ([http://www.cspsteam.org/TJCSurgicalFireCollaborative/preventingsurgicalfires.html](http://www.cspsteam.org/TJCSurgicalFireCollaborative/preventingsurgicalfires.html)).
- 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, know that 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.
  - Understand 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 handy to put out a fire.²

**Other Strategies**

In addition to the strategies described previously, 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 may also be placed 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. Many times these products 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.

Conclusion

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. Taking proactive steps to avoid and control fire risks may help prevent a tragedy.
Endnotes


The information provided in this document should not be construed as medical or legal advice. Because the facts applicable to your situation may vary, or the regulations applicable in your jurisdiction may be different, please contact your attorney or other professional advisors if you have any questions related to your legal or medical obligations or rights, state or federal statutes, contract interpretation, or legal questions.


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