Updated Surgical Fire Prevention for the 21st Century

The Joint Commission

An otherwise healthy patient is taken to the operating room for the removal of a neck mole under monitored sedation. After the patient is given two liters of oxygen through nasal cannula and administered intravenous sedation, an alcohol-based skin preparation is applied to the surgical field.

As the surgeon uses electrocautery to coagulate bleeding, a flash occurs, and the surgical drapes ignite. After extinguishing the fire by pouring water on the surgical field, assessment of the patient reveals second-degree burns on the patient's face. Oxygen from the nasal canula had accelerated the fire and caused the nasal cannula to melt and adhere to the patient's face. The patient was transferred to the burn unit for care, and ultimately required reconstructive plastic surgery.[1]

This case illustrates one type of injury that can be sustained during a surgical fire. Surgical fires continue to occur and represent a significant risk to patients and healthcare professionals. This *Sentinel Event Alert* provides updated information and replaces one on this topic that published in 2003. The Joint Commission issues this alert to help healthcare organizations recommit to surgical fire prevention. There is no national repository collecting data on surgical fires, therefore, reliable data is difficult to obtain. ECRI, an independent, nonprofit organization dedicated to improving the safety, quality and cost-effectiveness of care across all healthcare settings worldwide, estimates that 90 to 100 surgical fires occur annually in the United States.[2] Surgical fires may not be reported because of embarrassment, potential adverse publicity, or the fear of investigation and possible litigation.[3]

Internal, unpublished analyses of reports in the Joint Commission Sentinel Event database have shown the leading factors contributing to surgical fires include shortcomings in teamwork and communication, work design, workforce/staff, and equipment. These factors include:

- A lack of a shared understanding and communication among surgical team members before or during the procedure.
- Insufficient time-out to assess fire risk or to perform a workflow verification step or safeguard.
- A lack of competency to understand or recognize risks.
- Overconfidence and risky behavior; distraction or loss of situational awareness.
- Equipment malfunction or failure.
- A lack of training or orientation to the equipment in the operating room.

Minding the elements of the "fire triangle" can reduce occurrences of surgical fires

Surgical fires can be prevented by creating awareness of and carefully monitoring elements of the "fire triangle:" 1) oxygen, 2) ignition sources and 3) fuel.

There are many potential contributing factors to surgical fires, including:

- Use of 100% alcohol for any preparation.
- Failure to allow alcohol-based field preparations to completely dry.
- Improper disposal of alcohol wipes or other prep material.
- Use of 100% oxygen.
- Poor training or failure to use proper precautions when employing electrosurgical devices.

- Using electrosurgical devices in ENT surgery with the patient under mask or nasal cannula oxygen administration.
- Improperly handling and storing light cable supply cords.
- Not placing an electrosurgical device back in its holder when not in use.

Most surgical fires and burns are associated with the use of an electrosurgical device while performing head and neck surgery.[4] In the opening case study, the ignition source is the electrosurgical device, the fuel is undried, alcohol-based skin preparation and surgical drapes, with oxygen serving as the final element of the fire triangle.

Element 1 of the fire triangle: Elevated levels of oxidizing agents increase the risk of fire

An elevated concentration of oxygen and other oxidizing agents that together is greater than the normal atmospheric oxygen level of 21% increases the risk of fire by decreasing the temperature at which fuels ignite.[5] Oxygen-enriched atmospheres are reportedly involved in 75% of surgical fires.[3]

The risk of fire is higher during head and neck, oral pharyngeal and rectal procedures, particularly when higher levels of oxygen or other oxidizers (e.g., nitrous oxide) may be present.[4] These highly combustible gases, combined with flammable substances in the airway and the energy of an electrosurgical device/laser comprise the three elements of the fire triangle that can result in an airway fire. Examples of flammable substances that may be present in airway fires include tracheal tubes, catheters, and surgical sponges.[4] Bowel gas ignitions are another source of surgical fires.[6]

Element 2 of the fire triangle: Electrosurgical devices – the most common ignition source

The use of electrosurgical devices cause about 70% of the surgical fires occurring annually in the United States.[7] One study found that surgical fires were most common with monopolar "Bovie" instruments (88% versus other instruments).[8] From Jan. 1, 2018 to March 29, 2023, 85 sentinel events related to fires or burns during surgery or a procedure were reported to The Joint Commission, with 58% of fires or burns associated with electrosurgical devices, and about 15% related to light sources for electrosurgical devices.

Other potential ignition sources, especially within oxygen-rich environments, are lasers and high-speed drills producing incandescent sparks, as well as coagulators, hot wire cautery and defibrillators.[9]

Element 3 of the fire triangle: Alcohol-based skin preparations among various fuel sources

Alcohol-based skin preparations, which are recommended by the Centers for Disease Control and Prevention for the preparations' antiseptic effectiveness,[10] are common fuel sources during surgical fires[1,9] when not allowed to completely evaporate. Other potential fuel sources include surgical drapes, sponges, towels, gauze, methane in bowel gas, and the patient's body hair.[7]

The Joint Commission requirements

Joint Commission Environment of Care (EC) Standard EC.02.03.01 element of performance (EP) 11 requires accredited organizations – including hospitals and office-based surgery centers – to:

- periodically evaluate potential fire hazards that could be encountered during operative or invasive procedures.
- establish written fire prevention and response procedures, including safety precautions related to the use of flammable germicides or antiseptics.

In addition, the hospital or practice should:

- manage risks related to hazardous materials and waste. (EC.02.02.01)
- mandate fire drills. (EC.02.03.03)
- collect information to monitor conditions in the environment, and, at least annually, review each environment of care management plan's objectives, scope, performance, and effectiveness. (EC.04.01.01)

Actions suggested by The Joint Commission

The Joint Commission suggests the following actions to prevent surgical fires.

1. To satisfy the Joint Commission requirements stipulated above, ensure that the time-out includes a robust fire risk assessment (FRA) for each surgical and endoscopic procedure. During a time-out before each procedure, assess the risks associated with all supplies and equipment to be used, including inspecting them to assure they are in good working order. Assess the location of the operation on the patient and the presence of ignition sources, fuel and oxygen in the environment. Have access to saline within the operating room and fire extinguishers in the procedural areas.

The FRA process from the AORN has been revised to reflect risk identification and interventions to

address risks that are present. The recommended questions include:

- Is an alcohol-based skin antiseptic or other flammable solution being used preoperatively? (Managing risks related to hazardous materials and waste is one of the Joint Commission requirements listed above.)
- Is open oxygen or nitrous oxide being administered and/or is the operative site above the xiphoid process (e.g., head, neck, chest) or in the oropharynx?
- Is an electrosurgical device, laser, or fiber-optic light being used?
- Are any other ignition sources (e.g., battery-powered cautery pens, defibrillators, drills, saws, burrs) being used?

The FRA includes a scoring mechanism that identifies the surgical fire risk as high, medium or low. The score initiates a conversation among team members to assure proper precautions.[11] In addition, a key can be provided to further guide steps to take in high-, medium-, or low-risk situations.

2. Anesthesia should maintain the local oxygen concentration at less than 30%, whenever possible.[6] If the patient requires oxygen greater than 30%, consider alternatives to using an open oxygen delivery method, such as an endotracheal tube (ETT) or laryngeal mask airway (LMA), if clinically indicated.[6]

Stop or reduce the delivery of supplemental oxygen or nitrous oxide to the minimum required to avoid hypoxia for at least one minute before the use of electrosurgical devices; battery-powered, hand-held cautery units; or lasers for head, neck, or upper chest procedures.[13] The American Society of Anesthesiologists (ASA) Task Force on Operating Room Fires Practice Advisory[12] states that surgeons should inform anesthesiologists before using a potential ignition source, and anesthesiologists should inform surgeons if there is a potential for an ignition source to be exposed to an oxygen-enriched environment.

3. Carefully manage electrosurgical devices, light sources and cables, surgical draping, and other risks during a procedure. These practices include avoiding the use of electrosurgical devices in the trachea or bowel;[9,13] using the lowest possible power setting for the electrosurgical device and keeping an active electrosurgical device or laser away from gas sources and flammable materials;[13] and placing the electrosurgical device pencil/handpiece or active electrode in a nonconductive safety holster when not in use.[9]

For light sources and cables, label illuminating light sources warning of the burn risk when the cable is not connected to the scope before activating the light source.[14] Keep the light source at the lowest brightness setting that allows for safe identification and dissection during the case. Place the light source in standby mode and disconnect the light cord from the light source or place protective covers/caps over the cord before use. Put the light source into standby mode if the cable is disconnected from the scope during surgery. Keep illuminated light cords away from drapes, patient's skin, personnel's skin, and any flammable material.[15]

Even momentary proximity between an illuminated laparoscopic or arthroscopic light lead and a surgical drape can cause a skin burn. The risk of injury rises with the brightness of the lamp used.[16] These types of burns often happen without the knowledge of the surgical team because burns from light sources associated with laparoscopic or arthroscopic procedures typically do not produce smoke or charring, even of surgical drapes.[14]

Have the Safety Data Sheet (SDS) for alcohol-skin preps and other potentially hazardous materials or chemicals used during surgery accessible in the surgical area, as well as in an area in the hospital that is staffed 24/7. Use other cognitive aids, such as one-page handouts or signs, to serve as safety reminders prior to surgery or in case of emergency.[6]

Assess hazards continuously during surgery. Each surgical team member assesses hazards under their own control, as well as observes the actions of all other team members. When using an open oxygen delivery device, configure surgical drapes placed near the patient's head to allow oxygen to flow freely and prevent accumulation under the drapes.[13] Identify patients who have used mannitol-based bowel preparations, who produce more gas than those who used polyethylene glycol or sodium sulfate preparations.[6] Use CO2 insufflation rather than air insufflation during endoscopic procedures to prevent bowel fires.

Encourage any member of the surgical team to speak up immediately if any preventable risk or evidence of a possible fire is observed.[9]

4. Provide training to operating room staff on how to avoid and manage fires and conduct fire drills, as

stipulated in the Joint Commission standards. Define and review the roles and responsibilities of each perioperative team member in the event of a fire in the operating room, including turning off ignition sources and managing fuel sources such as alcohol-based preparations and drapes. For example, the anesthesiologist bears primary responsibility for halting an airway fire by stopping the flow of oxygen to the patient.[11]

Focus on the importance of communication and situational awareness between team members (including pre-op) during training. Surgical errors, including fires, can result from faulty decision-making, false assumptions, misperceptions, distractions, and suboptimal decision-making strategies.[17] Instruct surgical team members to continually look for potential hazards within both their and others' areas of responsibility.

Practice responses to fires involving drapes, prep solutions and equipment through simulation drills and other training techniques.[18] This practice includes instruction on how to turn off oxidizing gases, use a fire extinguisher (whether water mist of CO2), and activate the local fire alarm.[6]

In addition, develop emergency evacuation procedures and identify the responsibilities of each team member. Identify evacuation sites as comparable as possible to the operating room environment. For example, if a patient requires oxygen, suction or monitoring, they should be taken to any patient care area where they can receive that care.[11] Also practice moving/relocating the patient.

5. Report all surgical fires into your facility's incident reporting system, even if no injury to the patient occurs. These reports provide opportunities to learn and prevent future fires that could result in harm.

6. Encourage education of all operating room personnel/team members about the risk of surgical fires. The Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) offers the complimentary Fundamental Use of Surgical Energy (FUSE) certification program for surgeons, as well as providing hospital compliance modules for all surgical team members. Encouraging this training is particularly critical for organizations that conduct endoscopic procedures.

In conclusion, surgical team members should be aware of the elements of the fire triangle that create "perfect storm" conditions in the surgical environment that can result in a surgical fire. Each member of the surgical team is responsible for assessing all hazards that could contribute to a surgical fire, as well as observing the action of all other team members and speaking up immediately if any preventive risk or evidence of a possible fire is observed.

Resources

Fire prevention algorithms

These one-page handouts serve as useful cognitive aids in the surgical environment.

American Society of Anesthesiologists Anesthesia Patient Safety Foundation (APSF)

AORN Fire Prevention Assessment Protocol (requires a subscription)

ECRI and APSF Surgical Fire Time-Out Poster

Other fire prevention resources

American Association of Nurse Anesthesiology

SAGES: Fire Prevention: Electrosurgical Safety in Laparoscopy (video)

Fire Risk Score for Avoiding Fires in Operating Room – An easy-to-use online tool for scoring fire risk in the OR

References

1. Cowles Jr. CE and Culp Jr. WC. Prevention of and response to surgical fires. *BJA Education*, 2017;19(8):261-266.
2. ECRI. Surgical Fire Prevention webpage. Accessed September 9, 2023.
3. ECRI. *Health Devices*. 2009;38(10).
4. Akhtar N, et al. Airway fires during surgery: Management and prevention. *Journal of Anaesthesiology and Clinical Pharmacology*, 2016 Jan- Mar;32(1):109-11.
5. Stormont G, et al. Surgical Fire Safety. (Updated Jan. 29, 2023) In: StatPearls (Internet). Treasure Island (FL): StatPearls Publishing; 2023.
6. Jones TS, et al. Operating room fires. *Anesthesiology*, 2019;130:492-501.
7. The Joint Commission. *Environment of Care (EC) News*. Making electrosurgery safer. May 2023, 26(5):13-16.
8. Overbey DM, et al. Surgical energy-based device injuries and fatalities reported to the Food and Drug Administration. *Journal of the American College of Surgeons*. 2015;221:197-206.
9. Ehrenwerth J. Fire safety in the operating room. *Up-To-Date*, 2022.
10. Berríos-Torres SI, et al. Healthcare Infection Control Practices Advisory Committee: Centers for

Disease Control and Prevention guideline for the prevention of surgical site infection, 2017. *JAMA Surgery*, 2017;152:784-91.
11. Osleger D. Preventing surgical fires with a surgical or fire risk assessment. Jensen Hughes blog. Aug. 8, 2019.
12. Apfelbaum JL, et al. Practice advisory for the prevention and management of operating room fires. *Anesthesiology* 2013; 118: 271e90.
13. Association of periOperative Registered Nurses (AORN). Fire Safety Tool Kit (requires a subscription).
14. The Joint Commission. *Quick Safety*. Preventing light source-related burns from laparoscopy, thoracoscopy and arthroscopy. Issue 69, April 2023.
15. Ball K. Lap Burn. Agency for Healthcare Research and Quality, PS Net. Oct. 1, 2004.
16. Chitnavis J. Silent burn: The hidden danger and effects of bright light from fibre-optic cables in arthroscopic knee surgery. *Journal of Surgical Case Reports*, 2020 Apr 7;2020(4).
17. Graafland M, et al. Training situational awareness to reduce surgical errors in the operating room. *British Journal of Surgery*. 2015 Jan;102(1):16-23.
18. Kezze I, et al. Risks and prevention of surgical fires. *Die Anaesthesiologie*, 2018;67:426-447.

Patient Safety Advisory Group
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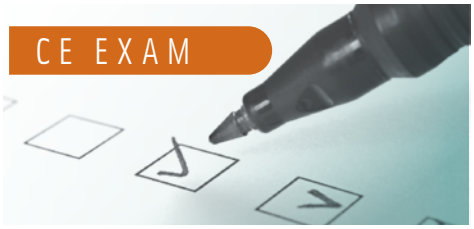

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1. The ECRI estimates the annual number of surgical fires at:
A. 60 - 69
B. 70 - 79
C. 80 - 89
D. 90 – 100

2. Which of the following is not part of the fire triangle?
A. Fuel
B. Oxygen delivery device
C. Oxygen
D. Ignition source

3. Which of the following surgical procedures would have a higher risk of fire?
A. Hip arthroplasty
B. Herniorrhaphy
C. Proctocolectomy
D. Femoropopliteal bypass

4. According to one study, surgical fires were most common with the use of:
A. Lasers
B. Monopolar electrosurgery
C. Bipolar electrosurgery
D. Drills and saws

5. The concentration of oxygen and other oxidizing agents should be maintained below:
A. 21%
B. 18%
C. 15%
D. 12%

6. Which of the following is a better method for delivering oxygen if a patient requires oxygen greater than 30%?
A. Nasal cannula
B. Tracheotomy
C. ET tube
D. Mask

7. Which of the following bowel preparation solutions should the patient avoid using?
A. Mannitol
B. Sodium sulfate
C. Electrolytes
D. Polyethylene glycol

8. What action should be taken if the CST must disconnect the light source from an endoscope?
A. Have light source placed on standby mode
B. Place the light source on the back table
C. Wrap the end of the light source with a wet sponge
D. Hand off the light source to the circulator

9. Which of the following is considered another oxidizer that can contribute to the risk of fire?
A. Ethrane
B. Isoflurane
C. Halothane
D. Nitrous oxide

10. Which of the following types of fire extinguishers should be available for use in the OR?
A. CO2
B. Foam
C. Wet chemical
D. ABC power

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