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# **Health Care Quality Safety Alert: Preventing Operating Room Fires During Surgery**



**Massachusetts Department of Public Health**

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The Massachusetts Department of Public Health (MDPH) Division of Health Care Quality is sending this alert to disseminate best practice recommendations that can assist hospitals in the prevention of operating room fires during surgery. Over the past three years, the Division of Health Care Quality has received incident reports involving fires that occurred in operating rooms during surgery. These fires were caused by the use of heat-producing surgical instruments in an oxidizer-enriched atmosphere. Fire hazards can be especially acute during surgery of the head and neck area because oxygen or oxygen and nitrous oxide tend to build beneath the surgical drapes or in the oropharyngeal cavity, creating an oxidizer-enriched atmosphere. Materials that are not considered flammable in normal circumstances can easily ignite in an oxidizer-enriched atmosphere and the resultant fire will burn more violently and at higher temperatures.

Our review of the incidents reported to MDPH and the medical literature published by ECRI and others reveals that the three elements necessary for combustion (an oxidizer, a combustible substance and source of ignition) are often present during any surgical procedure and that management of these three elements can prevent fires. The Department urges hospitals to evaluate the information provided in this document and to use it in the development and implementation of their policies and procedures to minimize the opportunities for fire to occur in the operating room during surgery.

**Information is presented in three parts:**

- 1. Recommendations**
- 2. Summary of Cases Reviewed by MDPH**
- 3. Bibliography of ECRI and ECRI-related Citations on Surgical Fires**

# 1. Recommendations

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## Summary of ECRI Safety Recommendations for Preventing Fires in the Operating Room (OR)

1. Make every effort to minimize the buildup of oxygen and nitrous oxide beneath drapes and in the oropharynx. For ophthalmic procedures, tent the operative and full-length body drapes from the end of the nose to facilitate the dissipation of gases. The use of an auxiliary support (such as a Mayo stand) may be necessary to achieve adequate tenting. Be aware of methods available to minimize oxygen buildup beneath drapes and in the oropharyngeal cavity. Allow high concentrations of oxygen to dissipate before activating heat-producing surgical units. With an outlet, gravity will assist in pulling oxygen to the floor away from the patient.
2. Inflate endotracheal tube cuffs properly, and check for leaks with a stethoscope before and during the procedure. Stop leakage from around a cuff by inflating or repositioning it, and wait at least one minute before using an electrosurgical or cautery unit or a surgical laser in the oropharyngeal area.
3. Activate electrosurgical and cautery units and lasers *only* when the tip is within view. Do not allow the distal end of an operating fiberoptic light source to contact drapes or other flammable material. When electrosurgical units (ESUs), electrocautery units (i.e., hot wire cautery), and lasers are used, the user must take into account the heating power of the device and the susceptibility of ignition in or near the operative site, especially in oxygen or nitrous oxide enriched atmospheres. Other ignition sources (such as incandescent sparks caused during cauterization) are unpredictable so emphasis should be placed on reducing the level of the oxidizer in the operative site.
4. If high oxygen or nitrous oxide concentrations in the operative site are unavoidable, use the lowest acceptable power settings on the ESU. For ophthalmic work use the lower-temperature cautery probes (consistent with therapeutic needs).
5. Remove from service and replace all electrosurgical units that lack audible activation tones. Replace units that have adjustable activation tones, or contact the ESU manufacturer, and request that the minimum volume setting be modified to ensure that it remains constantly audible when turned on.
6. Always place ESU active electrodes in a safety holster when not in active use. If using a holster is inconvenient or awkward (e.g., when using endoscopic electrosurgical electrodes), place the electrode away from the patient and surgical drapes on an instrument tray or Mayo stand; if this is not possible, disconnect the active electrode cable.
7. If the procedure and patient condition permit (as head and neck surgery frequently does) anticipate the use of electrosurgery or cautery by at least one minute and discontinue oxygen administration to the patient. Oxygen may be re-administered following the use of the electrosurgical or cautery unit.
8. Develop protocols to ensure communication between the surgeon and the anesthesiologist during patient preparation and surgery.

9. Become familiar with the hazards of enriched atmospheres including the various ignition sources present in the operating room and combustible substances that are likely to be encountered. Be aware that an increased level of oxygen or nitrous oxide can dramatically lower the ignition temperature of combustible substances (see p. 6, “Table of Typical Coexisting Ingredients that Could Cause an OR Fire”).
10. If oxygen or nitrous oxide is being administered during head and neck surgery, make hair near the operative site (e.g., eyebrows, mustaches, and beards) nonflammable by coating it thoroughly with a water-soluble surgical lubricating jelly. This practice should minimize the chance that the hair will either be the primary point of ignition or add fuel to a fire originating elsewhere.
  - a) The extent to which hair around the mouth should be coated with jelly may be dictated by the procedure and the draping technique. ECRI recommends that the jelly cover the patient’s mustache and beard for at least 5 cm from the edge of the mouth.
  - b) The need for coating the eyebrows also depends on the procedure and draping techniques. In many cases of ophthalmic surgery, the eyebrows are covered by a drape, and the application of jelly would have minimal benefit. However, it may be prudent to apply the jelly to the eyebrows if they are within the operative area and oxygen or nitrous oxide is being administered.
11. Minimize liquid alcohol solutions in pools around the patient or in open containers, allowing time for thorough drying of applied solutions before draping, and ensure dissipation of alcohol vapors before using any heat source near the patient.
12. Take the time to check that volatile fuels have fully evaporated on and under the point of application to prevent them from being ignited.
13. Develop and implement pre-operative patient instructions identifying products such as facial creams, hair care products, or other preparations that should not be used by the patient before surgery. Hair care products and facial creams can add to the fuel load, especially alcohol-based products. The varnishes and oils left by hair and skin care products and many medications have high ignition temperatures and are not ordinarily flammable. In oxidizer-enriched atmospheres, they are very flammable but no more so than the hair, drapes and plastic present during surgery.
14. Provide periodic education of operating room staff and physicians regarding the prevention of fire in an oxidizer-enriched atmosphere, management of fire that directly involves the patient and/or staff members, and standard fire policies and procedures including notification of the fire department, MDPH and the JCAHO or other regulatory agencies.
15. Conduct routine fire drills.

16. Post prevention reminders, recommendations, guidelines and information where it is visible and easily accessible to OR staff.
17. Be aware that inattention (which accompanies familiarity with equipment and procedures) can be a factor that contributes to a fire hazard.
18. Develop procedures and educate staff on the Quality Improvement process to be used following any fire. Include guidelines for the examination of instruments and materials, and the process for conducting an internal review.

## ECRI's Table of Typical Coexisting Ingredients that Could Cause an OR Fire<sup>1</sup>

Oxidizers	Ignition Sources	Combustible Substances
Oxygen	Electrosurgical units	Patient (hair, GI tract gases)
Nitrous oxide	Electrocautery units (both battery and line operated)	Prepping agents (Degreasers [ether, acetone; freon is nonflammable])
	Surgical lasers	Aerosol adhesives
	Fiberoptic light sources	Alcohol (also present when spilled from gut suture packets during opening)
	Incandescent spark	Tinctures (Hibitane [chlorhexidine digluconate]; Merthiolate [thimerosal])
	Static discharge spark	Linens (drapes [nonwoven, woven, and adherent]; gowns; masks; hoods; caps)
		Dressings (gauze, sponges, adhesive tape [cloth, plastic])
		Ointments (Collodion; Petrolatum [petroleum jelly]; Tincture of benzoin; aerosols (e.g., Aeroplast®); paraffin; white wax)
		Plastic/rubber products (blood pressure and tourniquet cuffs, gloves, stethoscope tubing)
		Anesthesia components (breathing circuits, masks, airways, endotracheal tubes)

<sup>1</sup> Excluding flammable anesthetics

## 2. Summary of Cases Reviewed by MDPH

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### Case 1:

As surgery was being performed on a female patient, the draping over the patient caught fire causing first degree burns on the patient's neck and shoulder. The surgeon immediately removed the draping, threw it on the floor, and stomped out the fire. The anesthesiologist opened two bags of intravenous fluid and poured the liquid over the drapes dousing the smoke and flames that remained. The patient was moved to another operating room and her surgery was completed. The patient recovered from both her surgery and the burns. During the hospital's internal investigation, the fire scene was re-created. It was determined that the oxygen build-up beneath the surgical drapes created an oxidizer-enriched atmosphere. When the surgeon used a heat-producing surgical instrument the drapes caught on fire.

- **Oxidizer:** oxygen build-up beneath the surgical drapes
- **Source of Ignition:** electrosurgical unit
- **Combustible Substance (fuel):** drapes

### Case 2:

While a patient was undergoing a rhytidectomy, a flash fire was observed on the left back side of the patient's neck. The surgical drapes covering the patient's chest caught fire. The circulating nurse promptly extinguished the fire with saline. The patient sustained second degree burns on her left posterior neck and on her chest. The burns were treated and the surgery was completed. The patient was admitted to the hospital for overnight observation. The patient was discharged home the following day with visiting nurse services for continued care of the burns.

During the hospital's internal investigation, the fire scene was re-created. It was determined that it was the practice of the anesthesia service to place oxygen tubing (without oxygen flowing) on the operative field so that it would be readily available if needed. The scrub nurse was aware the oxygen tubing was on the operative field and that it was covered by the surgical drapes.

The circulating nurse could not recall seeing the oxygen tubing but stated it was routine practice for the anesthesiologist to place the oxygen tubing on the operative field. The clinical resource nurse, who relieved the circulating nurse for lunch, stated she looked for an oxygen source and did not see any. Twenty-five minutes later, the clinical resource nurse saw the flash fire. She reported that when the surgeon was using the cautery on the left side, at the back of the patient's neck, it came in contact with the patient's hair and ignited. The surgeon reported that the fire traveled down through the drapes and to the oxygen tubing, which in this case had oxygen flowing. It was also determined that the patient, knowing that she would not be able to wash her hair for several days following the procedure, had applied hair conditioner the night before and had not rinsed it out. Additionally, the investigation determined that the fire alarm was not pulled at the time of the fire as required by the hospital's Fire Safety Program. The anesthesia service immediately discontinued their practice of placing oxygen tubing on the operative field. The manufacturer evaluated the electrocautery unit used during the patient's surgery and no malfunction was identified. The hospital's Safety Policy was revised and staff education was provided by the hospital.

- **Oxidizer:** oxygen build-up beneath the surgical drapes
- **Source of Ignition:** electrocautery unit
- **Combustible Substance (fuel):** hair, oxygen tubing, drapes, patient's hair conditioner

### Case 3:

A flash fire occurred when electrocautery was used to remove a skin graft from the left side of a male patient's neck during reconstructive surgery for a basal cell carcinoma of his nose. The procedure was being done under local anesthesia with intravenous sedation instead of the preferred general anesthesia, as the patient's respiratory status was very poor. The patient required oxygen, which could not be administered by facemask (as the surgery was on the nose), so the anesthesiologist taped oxygen tubing to the right side of the patient's jaw. Oxygen flowed across the patient's nose and mouth. In order to maintain a sterile field for the surgeon, a paper drape was placed across the lower part of the nose and mouth. This drape was continuous with a drape over the patient's left shoulder. The patient's head cap caught on fire. The fire was promptly extinguished. The patient sustained a second-degree burn on the face and singed eyebrows. The burns were treated and the surgery was completed. The patient was admitted to the hospital for overnight observation. He was discharged home the next day with visiting nurse services for continued care of his burns.

A hospital internal investigation was conducted. It was determined that both the surgeon and the anesthesiologist were aware of the oxygen and the oxygen-tubing placement. They believed that the oxygen was sufficiently distant from the left shoulder and the surgical field was open enough to prevent oxygen pooling beneath the drapes so that it was safe to use electrocautery. The surgeon had used electrocautery at the graft site approximately six times prior to the fire. The hospital's Clinical Engineering Department evaluated the electrocautery unit used during the patient's surgery and identified no malfunction. The hospital developed a new policy concerning oxygen use when giving monitored anesthesia care during procedures involving the head, face, and neck. The electrocautery policy was revised to prohibit the use of electrocautery equipment in the presence of flammable agents (e.g., alcohol, tincture-based fluids, an oxidizer-enriched environment, etc.) and to warn of possible pooling of oxygen beneath surgical drapes. Staff education was provided by the hospital.

- **Oxidizer:** oxygen build-up beneath the surgical drapes
- **Source of Ignition:** electrocautery unit
- **Combustible Substance (fuel):** head cap and facial hair

### Case 4:

A flash fire occurred when electrocautery was used to control bleeding at the operative site of a male intensive care unit patient who was undergoing a tracheostomy procedure to improve his airway. The procedure was being done under general anesthesia. The patient was intubated and on a ventilator with a high oxygen concentration of 50%. The fire was promptly extinguished. The endotracheal tube was removed. A bronchoscopy was performed and patient's bronchial tubes were flushed with a saline solution. The patient sustained superficial burns in his mouth and redness and swelling in the trachea. The tracheostomy was completed and the patient was ventilated without difficulty. He was transferred back to the intensive care unit. A hospital internal investigation was conducted. The surgeon had injected a local anesthetic into the trachea prior to cutting the trachea open to insert the tracheostomy tube. He noted bubbling, indicating an air leak, when he opened the trachea. The surgeon thought the local anesthetic injection needle might have punctured the cuff surrounding the endotracheal tube causing the air leak. The surgeon believed the leak (oxygen-enriched air) caused the fire. The electrocautery unit used during the patient's surgery was evaluated and no malfunction was identified. New policies regarding management of fire in the operating room, administration of oxygen during



surgical procedures involving the head and neck, and the use of electrocautery were developed. Staff education was provided by the hospital.

- **Oxidizer:** oxygen build up in the trachea due to endotracheal tube air leak
- **Source of Ignition:** electrocautery unit
- **Combustible Substance (fuel):** endotracheal tube

#### **Case 5:**

A flash fire occurred when electrocautery was used to cauterize a bleeding site when a female patient was undergoing a bilateral blepharoplasty and repair of her left earlobe at a hospital's day surgery unit. The surgical drapes covering the patient's face caught fire. The fire was promptly extinguished. The patient sustained burns on the right side of her face and on her lips. An ear, nose and throat physician conducted an interoperative consultation to evaluate the lining of the patient's upper airway for injury; no injuries were found. The cornea of the patient's right eye was also examined for injury; no injury was found. The patient's burns were cleansed and treated. Surgery on the patient's upper eyelids was completed, but surgery on the lower eyelids and repair of the left earlobe were deferred. The patient was discharged home.

A hospital internal investigation was conducted. The patient's procedure was being done under local anesthesia with intravenous sedation. The patient was receiving supplemental oxygen at 6 liters per minute by nasal cannula. The patient's face was prepped and surgical drapes were placed. The nasal cannula was covered by one of the drapes. The surgeon had used the electrocautery unit on the patient's right upper eyelid several times prior to the fire. It was determined that the patient had applied Preparation H™ to her face the morning of the surgery. The active ingredients of Preparation H™ include petrolatum (71.9%) and mineral oil (14%). Additionally, the investigation determined the operating room's red emergency button did not work when operating room personnel pressed it at the time of the fire.

The electrocautery unit used during the patient's surgery was evaluated and no malfunction was identified. Policies regarding administration of oxygen during surgical procedures involving the head and neck and the use of electrocautery were reviewed and revised. The hospital also revised the pre-admission test form to include patient prep information/instructions given to patient at time of admission. Staff education was provided by the hospital. The operating room emergency buttons were repaired and a procedure for periodic testing of the emergency buttons was implemented.

- **Oxidizer:** oxygen build-up beneath the surgical drapes
- **Source of Ignition:** electrocautery unit
- **Combustible Substance (fuel):** drapes, facial hair, facial moisturizer

### **3. Bibliography of ECRI & ECRI-related Citations on Surgical Fires**

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## **Acknowledgements**

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## **ECRI**

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ECRI is an independent nonprofit health services research agency that focuses on healthcare technology, healthcare risk and quality management, and healthcare environmental management. The monthly journal *Health Devices* and the Health Devices Alerts database are published by ECRI. ECRI's Medical Device Safety Reports are posted at its free clinical web-site at [www.mdsr.ecri.org/](http://www.mdsr.ecri.org/)