Laser Surgery and Fire Hazards in Ear, Nose, and Throat Surgeries

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KEYWORDS

- Fire triangle • Airway fires • Laser surgery
- Operating room fires • Fire management/prevention
- Anesthesiology

Fires in the operating room are a potential hazard to patients and operating room personnel. Data published in the *Health Devices* in 2009 estimate that there are approximately 550 to 650 surgical fires occurring in the United States each year.[1] Although this is an extremely small percentage of the total annual surgical cases (approximately 65 million each year), operating room fires can have devastating results. In 2003, the Joint Commission published a sentinel event alert, Preventing Surgical Fires, which prompted increased awareness in the surgical community. The American Society of Anesthesiologists has created a task force on operating room fires, and the American College of Surgeons has included surgical fire prevention as a session at its annual conference.

There are several ways in which an operating room fire can lead to injury. Operating room fires can produce significant thermal injury, leading to partial-thickness or full-thickness burns, the latter requiring skin grafting. Destruction of the skin and mucous membranes predisposes the burnt victim to fluid and electrolyte loss, heat loss, and infection. Swelling and edema of the airway are common after any degree of burn in the airway and can lead to life-threatening airway obstruction. Toxins released from burning plastics can also cause inhalation injuries and/or asphyxiation. These toxins include hydrogen, chloride, cyanide, phenols, aldehydes, and other complex hydrocarbons. In addition, most operating room fires result in incomplete combustion, which produces and releases partially oxidized molecules, such as toxic carbon monoxide, acidic free hydrogen, and unburned carbon or soot.

The fire triangle has become the standard for diagramming the 3 necessary components for combustion (**Fig. 1**). The triangle includes an oxidizer, an ignition source, and

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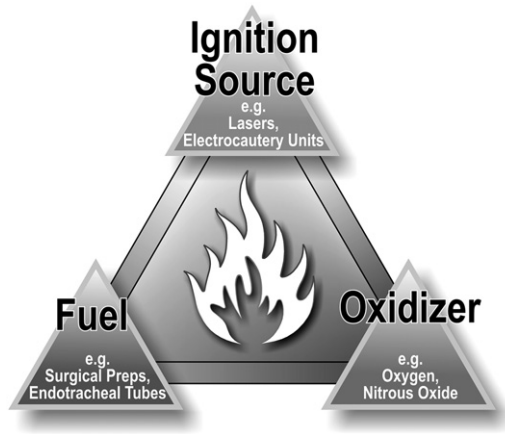

Fig. 1. The "fire triangle" diagramming the 3 necessary components for combustion.

a fuel. When these 3 elements interact under the proper conditions, a fire occurs. These 3 elements are often present in the operating room during surgery. When these elements are in close proximity, there is a high potential of an operating room fire. Anesthesia providers typically supply oxidizers, such as oxygen, nitrous oxide, and air. Surgeons can provide a source of ignition, typically in the form of an electrosurgical unit (ESU), lasers, an electrocautery unit, or a fiberoptic light source. A defibrillator can spark and ignite a fire. Common fuels in the operating room include alcohol-rich prepping agents, surgical drapes and gauzes, tubes and masks, and even gastrointestinal gases and hair.

One of the first steps that the anesthesia staff can do to decrease the risk of operating room fires is to control the oxidizers. Ambient air can support the combustion of many potential fuels in the operating room. Ambient air is composed of 21% oxygen and 78% nitrogen, with fractional percentages of argon, carbon dioxide (CO_2), and other gases. Although air contains enough oxygen to support combustion, oxygen-enriched atmospheres (ie, pure oxygen or air-oxygen mixtures) greatly enhance the rate of ignition and combustion. These oxygen-enriched atmospheres are often created when oxygen concentrations above that in ambient air are provided to patients via routes such as nasal cannulas, face or laryngeal masks, or endotracheal tubes. Oxygen-enriched environments are involved in most operating room fires and present an often-unsuspected fire risk during head, neck, and airway surgeries. Oxygen-enriched atmospheres lower the temperature at which fuels ignite, and cause fires to burn more intensely and spread more quickly. Nitrous oxide also supports combustion by exothermic disassociation, releasing heat and oxygen. Operating room fires involving mixtures of nitrous oxide and oxygen are as easily ignited and as severe as fires involving 100% oxygen. For these reasons, the fire risk when nitrous oxide is mixed with oxygen should be considered equivalent to those risks associated with administering 100% oxygen.

In 2009, the Emergency Care Research Institute (ECRI) along with the Anesthesia Patient Safety Foundation supported the following new guidelines on controlling oxygen delivery during head, face, neck, and upper chest surgery.[1] Use only air for open delivery to the face as long as spontaneously breathing sedated patients can maintain their blood oxygen saturation without extra oxygen. However, if the patient cannot maintain an adequate blood oxygen saturation level without supplemental