

Fire Safety in the Operating and Procedural Room – An Online Education Module

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Outline for Operating Room Fire Safety Education Module

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Fire Safety in the Operating and Procedural Room

Introduction

An evidence-synthesizing project utilizing research from scientific literature and recommendations from leading professional organizations on fire safety was completed for this module. The purpose of this module is to educate staff about fire safety in the operating and procedural room. Specifically, this module will educate providers about: (1) the importance of fire safety, (2) the fire triangle, (3) scenarios highly conducive to fire, (4) fire prevention using the fire risk assessment score, (5) management of fires on the patient and in the airway, and (6) fire interventions. For the purposes of this paper, the term “operating room (OR)” will include all areas of the healthcare setting where procedures are performed.

Importance of fire safety

There is an estimated 550 to 650 OR fires each year in the United States.¹ These numbers may be underestimated because many states do not have mandatory reporting of surgical fires. When compared to the number of surgeries, the occurrence of fires in the operating room is relatively rare. However, when fires do occur they are often catastrophic for the patient.¹ Patient injuries can be severe, and in some cases can lead to death. Patients that do survive often require extended hospital stays and repeated OR visits to treat their fire-related injuries. The surgical team and facility often face severe emotional, legal, and economic consequences. The Joint Commission has labeled OR fires as a sentinel event.² OR fires are largely preventable, yet they still occur today. OR fires are preventable with communication, appropriate training, and management of risks.³ It is the responsibility of the operating room staff to protect patients from fires.

Statistics about OR Fires

Researchers reviewed the American Society of Anesthesiologists (ASA) Closed Claims Database from 1985 to 2013 to assess patterns of injury and liability associated with operating room fires.⁴ Most fire claims (81%) occurred in patients who received monitored anesthesia care (MAC) with open oxygen delivery for upper chest, neck, and head procedures.⁴ Electrocautery and electrosurgery were the ignition source in 90% of fire claims. Oxygen served as the oxidizer in 95% of electrocautery-induced OR fires. Electrocautery fires during MAC increased from 6% of MAC claims during 1985-1989 to almost one-third of MAC claims during 2000-2009.⁴ Common high-risk procedures included temporal artery biopsy, carotid endarterectomy and other neck procedures, and procedures on the upper chest. The most common airway devices used to administer supplemental oxygen were open delivery systems including nasal cannulas (53%) and face masks (34%). Seventeen percent of electrocautery-induced fires occurred during general anesthesia (GA). The majority of GA cases occurred during tonsillectomy or tracheostomy surgeries using an endotracheal tube, with cuff leaks or ruptures being the most common culprit. Sources of non-electrocautery fires included lasers and a defibrillator. Payments to patients were more often made in fire claims (78%) compared to other database claims, with a median payment amount of \$120,166.⁴

The Fire Triangle

The “fire triangle,” also known as the “fire triad” is made up of 1) an oxidizer (such as oxygen or nitrous oxide [N₂O]), 2) an ignition source (such as electrosurgical units or lasers), and 3) a fuel (such as prep solutions or drapes). A fire will occur when these three components come together in the proper proportions and under the right conditions. Keeping the elements of the fire triangle from coming together in ways that could lead to a fire requires that all surgical team members are aware of the risks, and consistently follow practices that can minimize those risks.¹ Each member of the surgical team is often responsible for one of the elements of the fire triangle. Anesthesia providers are involved primarily with oxidizers; surgeons with ignition sources; and nurses, surgical technicians, and assistants with fuels. However, each member of the surgical team should understand the fire hazards that are present on each side of fire triangle.¹ Many times the responsibilities will overlap. The following section will go into further detail about each element of the fire triangle.

Oxidizers

Oxidizers are gases that can support combustion and accelerate the burning process. The most common oxidizers in the OR are oxygen, and N₂O. Fire is more likely to erupt if fuels are present in an environment with a high concentration of oxygen or N₂O.

Oxygen

Ambient air has about 21% oxygen, 78% nitrogen, and fractional percentages of argon, carbon dioxide, and other gases.¹ Any time the environment around a patient or operating area contains more than 21% oxygen it is considered an oxygen-enriched atmosphere (OEA). High concentrations of oxygen are common in the OR, and are administered via tracheal tubes, laryngeal mask airways (LMA), face masks, nasal cannulas, and other airway devices in order to oxygenate the patient. Because these devices are in/around the airway, the OEA can pose a high fire risk for surgeries on the head, neck, face, and upper chest. Oxygen is heavier than room air and can settle under drapes and other low-lying areas in the surgical field.⁵ If an ignition source causes a spark on the surgical field or drapes in this OEA, a fire can rapidly start. OEAs lower the temperature at which a fuel will ignite. Many materials that will not burn or sustain a flame in ambient air will do so in OEAs. Fires involving OEAs are hotter, more intense, and spread more rapidly.¹ The major recommendations regarding the use of oxygen include eliminating the traditional practice of open delivery of 100% oxygen for high-risk cases where an ignition source will be close to the face, neck, and upper chest of the patient.^{1,2} If supplemental oxygen is needed, the oxygen concentration should be kept as low as possible, at least less than 30%. If this is not possible and the situation allows for it, the airway should be secured through intubation or use of a LMA to minimize an OEA that is in close proximity to an ignition source. These recommendations will be explained later in this module.

Nitrous Oxide (N₂O)

N₂O is an anesthetic and analgesic gas that is sometimes administered by anesthesia providers during surgery. N₂O supports combustion by exothermically dissociating, thereby releasing heat and oxygen.¹ The fire hazards of N₂O are identical to that of oxygen.

Fuels

Fuels are prevalent in the operating room and many of the materials that are used on, or in, the patient are fuels. The human body is also a source of fuel for a fire. Examples of fuels include: chemicals (e.g. alcohol based prep solutions), drapes, dry sponges, body hair, and intestinal gases.⁶ Fuels have differing capacities to burn, and all fuels ignite more easily in an OEA. The flammability characteristics of these fuels can be affected by interaction among other fuels. For example, alcohol can be absorbed into a towel, making the towel more flammable, or a fiberoptic light cable can penetrate a surgical drape and ignite underlying materials.¹

Alcohol and other volatile organic chemicals

Volatile organic chemicals include alcohol, acetone, and ether used in liquids such as skin preps, tinctures, degreasers, dressings, and some suture pack solutions.¹ Alcohol-containing prep solutions and volatile compounds were present in 15% of OR fires during MAC cases.⁴ Alcohol-based surgical prep solutions (e.g. ChloroPrep, DuraPrep) contain up to 70-75% isopropyl alcohol.² These solutions should be allowed to dry at least three minutes prior to surgical draping in order to prevent surgical fires.^{1,2,6,7} Not all surgical prep solutions are flammable. For example, povidone-iodine solutions (e.g. Betadine) and chlorhexidine soaps (e.g., Hibiclens) are not flammable and do not require a drying time before use of an ignition source.² Healthcare providers should read the ingredients on the package inserts, and follow the guidelines, in order to prevent surgical fires. Alcohol-based fires may not be recognized until later in the burning process because the flame is nearly invisible.^{1,2}

Endotracheal tubes, LMAs, and other airway devices

Airway devices are typically made from polyvinyl chloride (PVC), latex rubber, or silicone. These materials are all flammable. Laser-resistant tracheal tubes often contain one or more of these materials. These tubes are resistant to specified laser wavelengths, but can be flammable if exposed to different laser wavelengths or other heat sources.¹ Fires with an airway device in place can result in serious injury.

Surgical material: drapes, gowns, sponges, etc.

Surgical materials are made of various types of fabrics. Some of these products are made with fire retardants, but they cannot be relied on to prevent surgical fires.¹ A phenomenon known as “surface-fiber-flame propagation” occurs in oxygen concentrations above 50%.¹ This phenomenon occurs when the fine nap fibers on cotton towels, drapes, and linens serve as a fuel that rapidly spreads a fire across the fabric surface.^{1,2}

Organic matter

Body tissue is flammable “if it has been fully desiccated by therapeutic heat, such as that from an electrosurgical unit or laser at the small target area of its application. The organic materials that remain after desiccation can ignite and become incandescent embers or flares of gas.”¹ Hair can ignite, especially if coated with wet alcohol. The fine sublayer of hair, called vellus hair, can trap oxygen when there is a high oxygen concentration.¹ This can lead to fiber-flame propagation. Dried hair spray does not enhance the ease with which hair may ignite, but can encourage burning after ignition.¹ Intestinal gases can ignite because these gases are composed of various concentrations of methane, hydrogen, and oxygen. Inhaled N₂O can diffuse into the bowel, or may diffuse into the pneumoperitoneum during laparoscopic procedures. After 30 minutes N₂O levels have been found to be high enough to increase the risk of ignition of intestinal gases.^{1,8,9}

Ignition sources

Ignition sources provide the heat/energy that can start a fire when in contact with a fuel source. Ignition can occur in ambient air, but is more intense in oxidizer-enriched environments. Surgical equipment is the primary ignition source. Alcohol based prep solutions should be allowed to completely dry before any ignition source is used.

Electrosurgery units

Electrosurgical units (ESU) are the most commonly used ignition source in the OR. Seventy percent of surgical fires involve electrosurgical equipment as the ignition source.¹ Electrosurgery passes a high-frequency electric current through tissue to cut, coagulate, desiccate, vaporize, or fulgurate. The high temperature electric arc can cause fuels to ignite. ESUs use either a monopolar or bipolar tip. The Emergency Care Research Institute (ECRI) has never reported a fire with bipolar electrosurgery. ECRI states that this is likely due to the low power used across the tips of the forceps and lack of arcing that can occur with the tips grasping the target tissue.¹ Sparks that are produced from cable failures and severed internal conductor cables can ignite a fire. This is most often seen with reusable monopolar cables. OR staff should inspect the ESUs and routinely replace ESUs that have a high amount of use.

Electrocautery

Electrocautery and electrosurgery both use electrical current to delivery energy, but they are not identical. Electrocautery uses electrical current to heat a wire or scalpel blade to a high temperature. Electrosurgery draws electrical current through the tissue rather than using the current to heat an electrode. Wire-type electrocautery probes can reach temperatures above 900 degrees Fahrenheit and have been known to cause surgical fires.¹

Lasers

Surgical lasers are the second most common ignition source involved in surgical fires.¹ Lasers use an intense beam of several electromagnetic radiation wavelengths to coagulate, cut, or vaporize tissue. A laser beam can ignite any dry material that it comes in contact with. Laser fibers can break apart, which results in an escape of energy to other flammable material.^{1,2} Surgical lasers, especially when used in oxidizer-enriched environments, can cause fires.

Fiberoptic light sources, including endoscopes

Fiberoptic light sources accumulate incandescent light energy and direct it into an optical fiber that then brightens specific areas. This energy can ignite surgical fuels. Fiberoptic lights are sometimes called “cold light” but are still capable of causing ignition, especially if the cable becomes disconnected from an output device such as a headlamp or lighted instrument.^{1,2}

Other potential ignition sources

Other ignition sources include coagulators, drills, defibrillators, and high-speed burrs. Failed electrical components on medical devices, such as an electrical circuit short or overload, are potential ignition sources for fires. There has been a reported case of a static spark causing an OR fire.² Carbon dioxide absorbent systems containing soda lime and zeolite additives have been linked as the cause of anesthesia machine fires. Chemical reactions between inhalation agents and carbon dioxide absorbents can produce heat and elevated temperatures than can result in self-combustion.²

Preventative Strategies for reducing OR fires

ECRI collaborated with the Anesthesia Patient Safety Foundation (APSF) to release the “New clinical guide to surgical fire prevention,” which contains updated information and new guidelines that should be implemented to reduce the risk of OR fires.¹ Since then, many of the leading professional organizations, including the ASA, AANA, and AORN, have followed suit. The APSF recently released a video on fire prevention and management.⁷ The new recommendations focus on eliminating open delivery of 100% oxygen during high-risk procedures or securing the airway if the patient requires an increased oxygen concentration. A survey found that viewing this video changed practice among anesthesia professionals. A significant impact on airway management and how anesthesia providers administer supplemental oxygen to high-risk patients was reported.¹⁰ UpToDate provides a detailed approach to fire prevention that uses the “Fire Risk Assessment Tool” and other formal fire prevention tools, such as the approach published by the APSF and an algorithm published by the ASA.²

Preventative Methods Based on the Fire Risk Assessment Score

The guidelines in this module will provide fire prevention strategies based on the fire risk score. An anesthesiologist named Kenneth Silverstein developed the Fire Risk Assessment Score.^{12,13} The Fire Risk Assessment tool is easy to use and is supported by data from closed malpractice claims.^{2,13} During the procedural timeout period, risk is assessed, and one point is awarded for each of the following major risk factors:

- 1.) Use of an open oxygen source. That is, the patient is receiving supplemental oxygen via any variety of face mask or nasal cannula.
 - This is a factor in 84% of OR fire claims.²
- 2.) Presence of an ignition source such as an electrosurgery unit, laser, or fiberoptic light source.
 - This is a factor in 90% of OR claims.²
- 3.) Procedure at or above the level of the xiphoid process.
 - This is a factor in 85% of OR fire claims.²

A score of 3 indicates a high fire risk procedure. A score of 2 indicates a low fire risk with potential to covert to high risk, or an intermediate-risk procedure. A score of 1 indicates a low fire risk procedure. Based on the fire risk assessment score the OR team should follow the recommendations listed for each category. Detailed guidelines for each fire risk category will be thoroughly discussed in the following section. As the patient’s fire risk score increases, the OR team should follow the guidelines listed for the patient’s highest score along with the standard fire safety precautions of the lower scores. For example, if a patient has a fire risk score of 3 (high fire risk), the OR team should implement all of the recommended guidelines listed under “High Risk” along with the standard fire safety recommendations.

Preventative measures during Low Risk Procedures

A fire risk score of 1 indicates a low risk procedure. The OR team should follow the standard fire safety precautions listed below.¹²

Recommendations for minimizing fuel risks^{1,2,12}

During Prep

- Be aware that alcohol-based preps are flammable.
- Avoid pooling or spilling of flammable liquid preps. Spilled or pooled agent should be soaked up and removed from the patient.
- Allow at least 3 minutes for flammable liquid preps to dry before draping. Increased time for drying may be necessary when solutions are applied to areas of the body that are hairy or in areas containing skin folds and body creases. Dryness can be tested with dry sterile gauze prior to electrosurgical use.
- Apply alcohol-based prep solutions with appropriately sized applicators. Using applicators that are too large for small anatomical areas such as the head and neck can result in accumulation of too much fuel and pooling onto surgical towels and drapes.
- Remove towels with flammable prep solutions.
- Keep drapes and fenestration towel edges as far from the incision as possible.

In General

- Use a standard draping procedure.
- Keep excess drape and towel edges as far from the incision as possible to prevent their ignition from electrosurgical flames or sparks.
- Moisten sponges and towels that are near an ignition source.
- Be aware of the flammability of tinctures, solutions, and dressings (such as benzoin and collodion) used during surgery, and take steps to avoid igniting their vapors.
- Moisten sponges to make them ignition resistant if an ignition source is used.

Recommendations for Minimizing Ignition Source Risks¹

Electrosurgery and Electrocautery

- Use the lowest possible voltage necessary.
- Place the active electrosurgical device in a holster or another location off the patient when not being used.
- The person directly holding the electrosurgical device should be the only one that activates it.
- The surgeon should activate the unit only when the active electrode tip is in direct view, especially if looking through a microscope or endoscope.
- Deactivate the unit before the active electrode tip leaves the surgical site.
- Never use insulating sleeves cut from catheters or packing material that is then placed over active electrode tips. These materials are not designed as insulators for the voltages present during electrosurgery, and can cause flame flare-ups.

- Dispose of electrocautery pencils properly by breaking off the cauterizing wire and capping the pencil.
- Remove unneeded footswitches so that they are not accidentally activated.

During Laser Surgery¹

- Limit the laser output to the lowest clinically acceptable power density and pulse duration.
- Test-fire the laser onto a safe surface such as a laser firebrick before starting the surgical procedure to ensure that the aiming and therapeutic beams are properly aligned.
- Place the laser in standby mode whenever it is not in active use.
- The surgeon should activate the laser only when the tip is in direct view.
- Deactivate the laser and place it in standby mode before removing it from the surgical site.
- Use surgical devices designed to minimize laser reflectance.
- Never clamp laser fibers to drapes because this can cause fibers to break.
- When performing laser surgery through an endoscope, pass the laser fiber through the endoscope before introducing the scope into the patient. Before inserting the scope in the patient, verify the fiber's functionality. This will minimize the risk of using a damaged fiber that could cause a fire.
- Use a laser backstop, if possible, to reduce the likelihood of tissue injury distal to the surgical site.
- Consider the use of towels soaked in sterile saline or water around the operative site to minimize the risk of igniting the towels.

Surgery with fiberoptic light sources¹

- Be aware that fiberoptic light sources can start fires. Complete all cable connections before activating the light source.⁶
- Never place active fiberoptic cables on drapes or other flammable materials.
- Place the fiberoptic light source in standby mode or turn the light source off when disconnecting cables.

Preventative measures during Intermediate Risk Procedures

A fire risk score of 2 indicates an intermediate risk procedure. The OR team should follow the standard safety precautions (as above), but be prepared to convert to high risk precautions if necessary.¹²

Preventative measures during High Risk Procedures

A fire risk score of 3 indicates a high risk procedure. The OR team should follow the standard safety precautions (as above) along with the high risk recommendations listed below.¹²

Recommendations for managing oxidizers

Traditionally, 100% oxygen has been used for open oxygen delivery to spontaneously breathing patients. However, this can promote the development of an OEA during high-risk procedures. New recommendations are now being promoted by APSF and were developed in collaboration with ECRI.¹

The major changes that are being advised for head, face, neck, and upper-chest surgery are:^{1,2,7,12,13}

- The traditional practice of open delivery of 100% oxygen should be discontinued with limited exceptions, which are discussed below.
- As long as a spontaneously breathing, sedated patient can maintain their blood oxygen saturation without extra oxygen, use only air for open delivery to the face.
- If the patient cannot maintain safe blood oxygen saturation without supplemental oxygen, then the airway should be secured by using a LMA or tracheal tube, so that oxygen-enriched gases do not vent under the surgical drapes. It is important to adequately inflate airway cuffs so that oxygen-enriched gases do not leak onto the surgical field.
- It is important to remember that, for surgery locations not in proximity to an oxygen source, open delivery of oxygen can be used, but the risk of fire is always present.

Exceptional cases:^{1,2,7,11}

- There are some surgical procedures around the head, face, neck, and upper chest where conscious sedation is required and oxygen delivered by nasal cannula or mask may be necessary to maintain adequate blood oxygen saturation. These may include cases such as carotid artery surgery, neurosurgery, and some pacemaker implantations in which the sedated patient needs to be able to speak during the procedure. There may also be unusual cases where the risk of securing the airway for a minor procedure is greater than careful open oxygen delivery.
- When delivering oxygen by nasal cannula or mask in exceptional cases, staff should not use auxiliary oxygen flowmeters which may be attached to an anesthesia machine and are only capable of delivering 100% oxygen. The goal is to deliver the minimum concentration of oxygen necessary to maintain adequate oxyhemoglobin saturation.
- Restricting the oxygen concentration to 30% or less will minimize the fire risk and may provide an acceptable oxyhemoglobin saturation. Delivered oxygen concentration is continuously monitored using an oxygen analyzer, while adequacy of oxygenation is continuously monitored with pulse oximetry. There

is no risk of a flash fire if oxygen concentration is less than 30%. But many items that do not burn in air will burn in 30% oxygen.

- Ideally, a method for blending air and oxygen should be used and the oxygen concentration gradually increased to the minimum clinically acceptable oxygen concentration to keep the patient safe. Delivery of 100% oxygen should be avoided unless clearly required to maintain adequate oxygen saturation. In addition, if the patient can tolerate it, lower the oxygen concentration, preferably to 21% (room air), at least three minutes before activating the ESU or other potential ignition source.
- Using a lower delivered oxygen concentration (30% or less), while following the additional recommendations regarding blending air and oxygen that are outlined below, will minimize fire risks. However, these measures are not a substitute for using air whenever possible.

Three Options for blending oxygen with air during exceptional surgical cases where open oxygen delivery is essential^{1, 2, 7}

1. Air-oxygen blender

- Use an air-oxygen blender independent of the anesthesia machine to provide gas to the nasal cannula or mask. This is the most reliable option.
- The primary advantages are the oxygen concentration is selected directly and these devices are accurate.
- Air-oxygen blenders may not be commonly available in anesthetizing locations.

2. Blended gas directly from a common gas outlet on a three gas (air, oxygen, and N₂O) anesthesia machine.

- Be aware that it requires very little oxygen added to air to enrich the oxygen concentration beyond 30%.
- A limitation to this option is that newer anesthesia machines may not have an available common gas outlet.

3. Blended air and oxygen via the patient Y-piece on the anesthesia breathing circuit

- For faster changes in oxygen concentration delivery, close the Adjustable Pressure Limiting (APL) valve. Closing the APL prevents the fresh gas from shunting to the scavenger system.¹⁴
- Use large diameter tubing to prevent high resistance in the circuit with subsequent high pressure and activation of the continuing pressure alarm. Use a standard facemask with the small diameter tubing removed or an aerosol facemask attached to the circle system by large diameter extension tubing.¹⁴
- This technique has the advantage of the ability to measure the concentration of oxygen delivered by the flow meters using the anesthesia unit's oxygen concentration monitor.

- The disadvantage is that it can take a long time for the oxygen concentration to change.
- Regardless of which open oxygen delivery method used, if at first 100% oxygen is delivered with the intent of lowering the oxygen concentration prior to using an ignition source, several minutes are required to reduce the oxygen concentration delivered to the patient and accumulating under the drapes. Incomplete dilution of high oxygen volumes and variable washout characteristics can allow pockets of oxygen to remain under the drapes. When the open delivery of oxygen greater than 30% under the drapes is unavoidable, the delivery of 5 to 10 L/min of air under the drapes can help wash out excess oxygen. Using a scavenger system consisting of a suctioning tube connected to wall suction can reduce the oxygen concentration beneath the drapes if an open oxygen source is being used.
- Stop supplemental oxygen at least three to five minutes before and during use of an ignition source if possible. Surgical team communication is vital for this recommendation. Before activation of any ignition source in a patient receiving oxygen via an open delivery system, the surgeon should notify the anesthesia provider so that oxygen can be discontinued or reduced to less than 30%.
- Nitrous oxide should be avoided for high-risk procedures.

Recommendations for minimizing fuel risks^{1,2,12}

- An oxygen-enriched environment can exist when drapes are placed over an oxygen delivery source without appropriate circulation.^{15,16}
- Assemble surgical drapes in a manner that minimizes oxygen buildup underneath the drapes.¹⁵
- Scavenge the operating field with suction or flush the field with medical air to minimize oxygen buildup.
- Use an adherent incise drape, if possible, to help isolate the surgical site from oxygen-enriched atmospheres and from flammable vapors beneath the drapes. The incise drapes can prevent gas communication channels between the under-drape space and the surgical site.¹
- Coat head and facial hair within the surgical site with water-soluble surgical lubricating jelly to make it nonflammable.
- Have sterile water or saline available for fire suppression. For procedures in the oral cavity, keep an available syringe full of saline.

Recommendations for minimizing ignition source risks^{1,2}

- If possible, avoid electrosurgical use altogether.
- If feasible, use an alternative to monopolar electrosurgery, such as bipolar ESU, a scalpel, or harmonic scalpel, which can minimize the ignition risk.^{2,7}

- Bipolar electrosurgery causes little or no sparking or arcing and, to the knowledge of ECRI, has not been involved in starting any surgical fires.¹
- If an ignition source is used in a high-risk procedure the surgeon should give the anesthesia provider adequate notice (three to five minutes) before activation of the ESU or other ignition source, so that oxygen concentration can be reduced to less than 30% and N₂O can be discontinued.²
- Use the lowest possible voltage necessary for electrocautery and electrosurgery.

In summary, the preventative methods that can be used for exceptional cases include blending air and oxygen, diluting the under draped surface with air and/or scavenging with suction, using alternative surgical modalities, and using modified draping techniques.

Preventing Fires That Can Occur Near Or In The Airway

Procedures that take place in or near the airway deserve special attention. The three elements of the fire triangle are often present during airway surgical procedures. For oropharyngeal procedures in an intubated patient, a cuffed endotracheal tube can help to prevent an oxidizer-enriched environment at the surgical site. The oxygen concentration should be reduced to $\leq 30\%$, and N₂O discontinued, when the surgeon gives notice for activation of any ignition source. At least three to five minutes is required to allow both the fraction of inspired oxygen (FiO₂) and fraction of expired oxygen (FeO₂) to be reduced to a safe level ($\leq 30\%$).² Control of both FiO₂ and FeO₂ in a closed delivery system depends upon the total gas flow. Monitoring the FeO₂ is important because the expiratory oxygen concentration may be $>30\%$ for a considerable time after the FiO₂ is in a safe range.¹⁷ Flooding the surgical site with carbon dioxide can prevent airway fires when ignition sources are used.^{18,19} Some of the common procedures in and around the airway, along with methods to prevent airway fires, are discussed below.

Oropharyngeal Surgery^{1,7}

- Using an oxygen concentration less than 30% without N₂O and the use of a tracheal tube that does not leak will reduce the risk of fire.
- Use suction with a metal cannula deep within the oropharynx to scavenge the gases from an intubated patient. Do not use plastic suction cannulas. Do not rely on electrosurgical suction coagulators for scavenging of oropharyngeal gases because the suction at the tip is not continuous.¹
- Keep all sponges and gauze thoroughly moist throughout the procedure to decrease the likelihood of ignition.

Tracheostomy¹

- Avoid electrosurgery or electrocautery to cut into the trachea. Instead, use a scalpel or scissors to enter the trachea itself.

- In cases where electrocautery is necessary to secure hemostasis, and high oxygen concentrations are unavoidable such as critically ill patients or an uncuffed tracheal tube in a child, flooding the surgical field with a carbon dioxide cannula can prevent fire.¹⁹
- Poor communication between the surgeon and anesthesia provider has often been the cause of fire during tracheostomies.²⁰

Surgical Bronchoscopy⁷

- Fire can occur when a laser fiber or electrosurgical device is activated in the oxygen-enriched lung.
- Oxygen concentration should be reduced to less than 30% when the surgical device is activated. Inspired and expired oxygen monitoring will confirm the desired concentration.
- High gas flows should allow for rapid reduction of oxygen concentration to facilitate surgery and rapid increase in oxygen concentration to avoid prolonged hypoxia.

Procedure with Laser Use^{1,2,11}

- Use appropriate laser-resistant tracheal tubes during upper-airway surgery. The ETT must be resistant to the particular laser used.
- Follow the directions in the laser tracheal tube product literature, which typically include information regarding the tube's laser resistance, use of dyes in the cuff to indicate a puncture, use of a saline-filled cuff to prevent cuff ignition, and immediate replacement of the tube if the cuff becomes punctured.
- Place wet gauze or sponges adjacent to the tracheal tube cuff to protect the tube from laser damage, and keep them wet.
- Moisten, and keep moist, any gauze or sponges used with uncuffed tracheal tubes to minimize leakage of gases into the oropharynx.
- During lower airway surgery, keep the laser fiber tip in view and make sure it is clear of the end of the bronchoscope or tracheal tube before laser emission.

Chest Cavity Surgery^{5,18}

- An open chest cavity can expose an oxygen-enriched environment that is in close proximity to an ignition source.
- Pulmonary blebs and other lung abnormalities can cause leakage of anesthetic gases onto the surgical field during chest cavity surgery.
- Pulmonary leaks should be surgically sealed as soon as possible and gauze that are placed over the leaks should be kept moist.
- If possible, keep the oxygen concentration less than 30%.
- Ensure that there is no gas leak from the ETT cuff of a double lumen tube that is on the operative lung side.¹⁸
- Continuous suction of the non-ventilating side of the double lumen ETT will decrease the amount of oxygen near the electrocautery.¹⁸

- In addition to using the lowest possible voltage for electrocautery, the surgical field can be flooded with carbon dioxide to decrease the chance of fire.¹⁸
- Communication between the surgical staff is imperative to decrease the risk of fire.

Facial Surgery^{15,16}

- Improper draping of the head and neck during facial surgeries can predispose to oxygen pooling when an open source of oxygen is used.
- The ignition source is in close proximity to the open oxygen source.
- Dilute the under draped surface with air.
- Provide oxygen only if necessary. Administer air only, or blended with oxygen if necessary to maintain saturations > 90%. The oxygen concentration below the drapes where the patient's face is located can be lower than normal room air concentrations if no airflow is delivered to the patient. Administration of air only may prevent hypoxia without increasing the fire risk.¹⁵
- Using a scavenger system consisting of a suctioning tube connected to wall suction at 170 to 190 mmHg can reduce the oxygen concentration beneath the drapes if an open oxygen source is being used.¹⁵
- If possible, drape the patient in a manner that cuts off the open oxygen from entraining the surgical site.

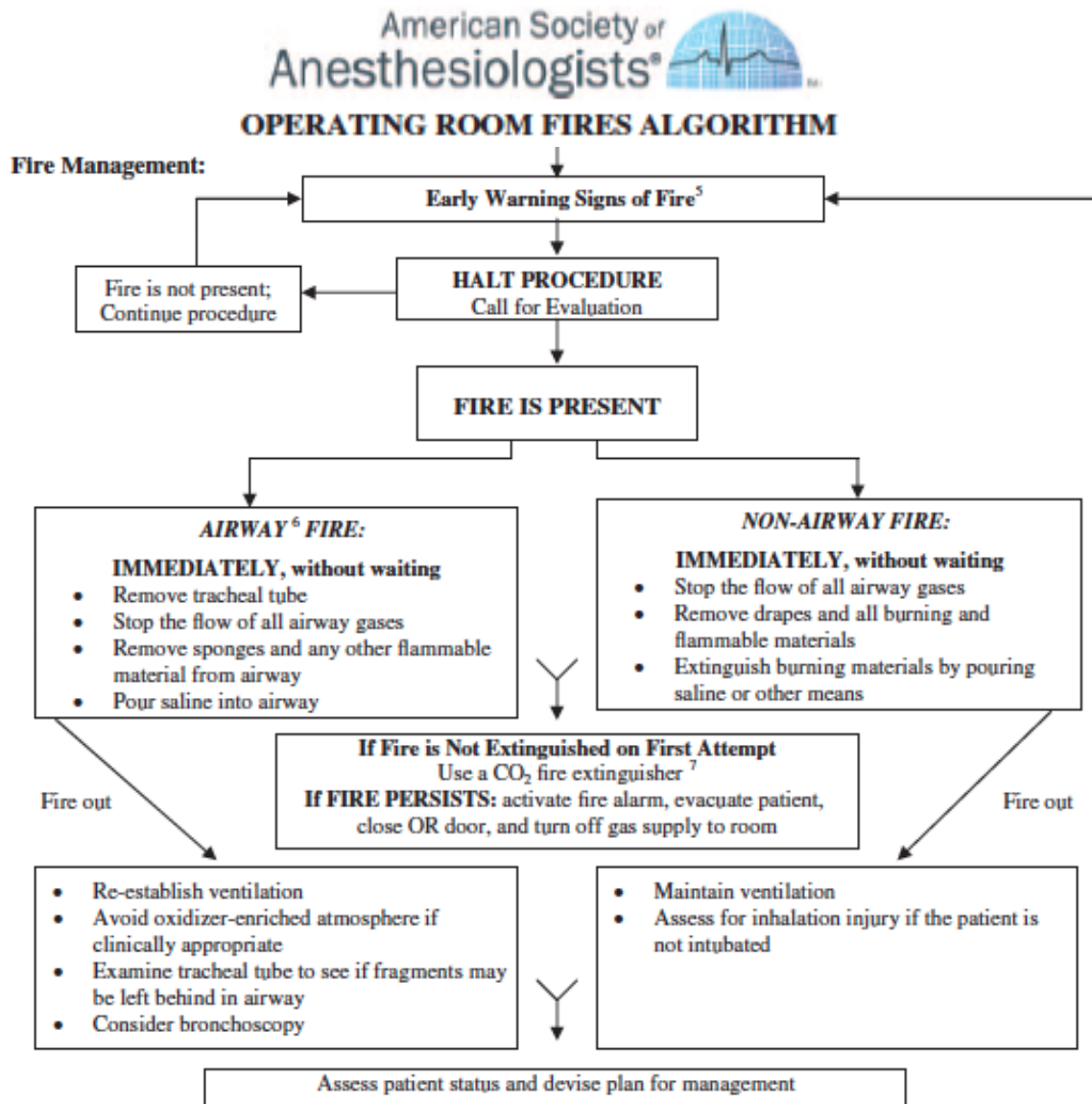
Cardioversion^{1,8,21}

- Fire can occur if a spark is generated in an oxygen-enriched environment.
- Defibrillator paddles may spark if positioned over a bony prominence or an EKG lead.
- Adequate pressure and low-impedance gel are required to prevent sparks from the paddles.
- It is recommended that oxygen delivery systems are removed and placed at least 3 feet behind the head of the patient prior to activating the defibrillator.

Fire Interventions

When early warning signs of a fire are noted, such as smelling smoke, hearing a pop, or seeing a flash, the procedure should be stopped and an evaluation of a fire should be performed.^{2,11} When a fire is definitely present, immediately announce the fire and initiate fire management tasks. Efforts are focused toward stopping the burning process and removing the fire source. The initial response to a surgical fire on a patient should be to stop the flow of gases to the patient and to remove the burning materials.¹ Retrieving a fire extinguisher should not be the first response because surgical fires can spread so rapidly that they will be out of control before an extinguisher can be used. An extinguisher should be used, if needed, only after initial steps are taken.¹ **Figure 1** displays the recommended fire management interventions for when a fire occurs on a patient or in an airway.¹¹

Figure 1. Algorithm for Fire Management Intervention¹¹



⁵ Unexpected flash, flame, smoke or heat, unusual sounds (e.g., a “pop,” snap or “foomp”) or odors, unexpected movement of drapes, discoloration of drapes or breathing circuit, unexpected patient movement or complaint.

⁶ In this algorithm, airway fire refers to a fire in the airway or breathing circuit.

⁷ A CO₂ fire extinguisher may be used on the patient if necessary.

Figure 1. Fire management interventions when a fire occurs on a patient or in an airway. This figure is reproduced with permission from the American Society of Anesthesiologists. “Practice Advisory for the Prevention and Management of Operating Room Fires” *An Updated Report by the American Society of Anesthesiologists Task Force on Operating Room Fires/2013* is reprinted with permission of the American Society of Anesthesiologists, 1061 American Lane, Schaumburg, Illinois 60173-4973.

Fires on the Patient^{1,2,6,7}

- Stop the flow of all airway gases to the patient. Removing the oxidizer can allow the fire to subside.
- Immediately remove the burning materials from the patient, and have another team member extinguish them. If this is not done, thermal injury from the heat source can continue even after the fire is put out. Removing these materials will allow staff to assess all the areas of the patient. Assess for smoldering elements and flames that may be hidden underneath the drapes.
- Extinguish small fires by patting with wet towels or sponges. Pat out the fire in a direction away from the body.
- Pour water or saline on any hot spots during the initial attempts to extinguish the fire.
- If the fire is not immediately extinguished after the first attempt, use a carbon dioxide fire extinguisher to put out the fire on burning material or the patient.
- Care for the patient.
 - The anesthesia staff should restore breathing, if needed, with air initially (never oxygen) until all possible sources of fire or reignition are suppressed.
 - The surgeon should deal with the patient's injuries caused by the fire.
 - The nursing staff should extinguish any remaining burning materials on the patient, or that were removed from the patient.
- Evacuate the patient if the room is dangerous from smoke or fire.
 - Initiate the RACE fire Protocol if a fire persists.^{2,6}
 - **Rescue** – Move patient to a safe location. Several rescuers will likely be needed to deal with disconnecting the patient from any devices.
 - **Alarm** – Activate the fire alarm system. The staff in nearby ORs should be alerted to the fire and kept informed in the event evacuation of their patients is necessary.
 - **Confine** – Close doors to the OR after evacuation. Occlude the space at the bottom of the doors to prevent smoke from entering other areas. The medical gas zone (shutoff) valves for the affected OR should be shutoff to prevent piped gas and vacuum systems from sustaining the fire. Electric power to the room should be turned off at the circuit-breaker panel outside the room. This will prevent electrical fires and electric shock hazard for firefighters who are using water.
 - **Extinguish** - Use a fire extinguisher as you retreat from the area. Do not pour saline or water on electric fire.

Fires in the airway^{1,2}

- At the first sign of fire in the airway, tracheal tube, or breathing circuit, immediately and simultaneously disconnect the breathing circuit from the tracheal tube and remove the tube. Flow of airway gases should also be stopped at the same time. Another team member should extinguish any items that were taken out of the patient's airway.
- Pour saline or water into the airway to ensure that any remaining embers are extinguished and to cool the tissues.
- Immediately remove any segments of the burned tube that may remain smoldering in the airway.

- Reestablish the airway, and resume ventilation with air until you are certain that nothing is left burning in the airway.
- Assess the upper and lower airways as soon as possible. This includes direct visualization of the upper airway with laryngoscopy to look for melted plastic fragments and soft tissue swelling, which could lead to imminent airway compromise. The lower airways should be assessed with bronchoscopy to look for soot and smoke residue, or other evidence of injury or inflammation caused by inhalation of toxic smoke.²

Management of Patient After Fire is Controlled²

- Perform a thorough, full-body assessment for burn injuries.
- Apply a dry sterile dressing to injured areas. Initially, no ointments or creams should be applied.
- Assess the patient and all personnel who were involved for smoke inhalation injury. Plastic products can give off toxic byproducts such as cyanide and phosgene, in addition to carbon monoxide. Initial evaluations may be normal in patients with inhalation injury who subsequently develop severe respiratory distress.
- Transfer patients who meet the American Burn Association's criteria for major burns to a burn center, this includes evidence of inhalation injury; full thickness burns of > 10% total body surface area; burns involving eyes, ears, face, hands, feet, or perineum likely to result in cosmetic or functional impairment; or chemical or electrical burns.²

It is the responsibility of each institution to provide fire prevention education. Each institution should have specific regulations and fire emergency plans for staff to review. Fire drills should be conducted periodically and all members of the surgical staff should be involved, as well as the local fire department.^{3,11} Participants should be familiar with locations and operation of the nearest fire extinguishers and cut-off switches for medical gases.

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Additional Resources

Emergency Care Research Institute (ECRI)

ECRI is an independent, nonprofit organization that is dedicated to bringing the discipline of applied scientific research to improving patient care. ECRI published an article titled, “New Clinical Guide to Surgical Fire Prevention” in 2009. The ASA and APSF have collaborated with the ECRI to publish updated practice advisories. Many of the recommendations in this education module come from the ECRI. The website below offers a multitude of surgical fire resources, including posters for surgical fire prevention and extinguishing a surgical fire.

https://www.ecri.org/Accident_Investigation/Pages/Surgical-Fire-Prevention.aspx

UpToDate

UpToDate is an evidence-based clinical decision support resource. They have a topic titled, “Fire Safety in the Operating Room”. Many of the recommendations in this education module come from UpToDate.

<http://www.uptodate.com/home>

Anesthesia Patient Safety Foundation (APSF)

With the assistance of ECRI, APSF produced an 18-minute long video titled “Prevention and Management of Operating Room Fires.” This video is free to download. The website below also provides additional posters and visual aids to download.

<http://www.apsf.org/resources/fire-safety/>

American Society of Anesthesiologists (ASA)

The ASA established a Task Force on Operating Room Fires. The task force, which included ECRI staff, published and updated a practice advisory for the prevention and management of OR fires. A thorough OR fire algorithm has also been produced by the ASA. Many of the recommendations in this education module come from ASA’s practice advisory. The website below provides a link to the practice advisory.

<http://anesthesiology.pubs.asahq.org/article.aspx?articleid=1918685>

American Association of Nurse Anesthetists (AANA)

The AANA provides education and resources for surgical fire prevention and management. Many of the recommendations in this education module come from the AANA. The website below offers additional resources for fire prevention and management.

<http://www.aana.com/resources2/professionalpractice/Pages/Surgical-Fires.aspx>

Association of Perioperative Registered Nurses (AORN)

The AORN has developed a fire safety tool kit that offers proactive tools to promote fire prevention, plan effective response strategies, and develop department-specific evidence-

based policies and procedures. The website below provides various fire risk assessment tools, a planning guide for OR fire drills, and educational resources.

<https://www.aorn.org/guidelines/clinical-resources/tool-kits/fire-safety-tool-kit>

Joint Commission (JC)

The JC published a Sentinel Event Alert called “Preventing Surgical Fires.” The alert summarizes fire prevention and management strategies. In 2015, administration of the Preventing Surgical Fires Initiative (PSFI) was transferred from the U.S. Food and Drug Administration to the JC. The website below provides new and updated resources for the PSFI.

<http://www.jointcommission.org/issues/article.aspx?Article=EKVJOiFMkdP6Aq3AetkXNJ6/M/jq7ROWsxFMULF2gXQ%3d>

National Fire Protection Association (NFPA)

The NFPA is a global nonprofit organization devoted to eliminating death, injury, property, and economic loss due to fire, electrical, and related hazards. The NFPA designs fire codes and standards in the U.S. They also sponsor the annual “Fire Prevention Week.”

<http://www.nfpa.org>

Professional Surgeon Societies

The American College of Surgeons has included surgical fire prevention as a session topic on several occasions. The American Academy of Otolaryngology-Head and Neck Surgery sponsors sessions on preventing and managing surgical fires. The Society of American Gastrointestinal Endoscopic Surgeons developed an official program for the safe use of electrosurgical devices, including education in the prevention of surgical fires. This Fundamental Use of Surgical Energy (FUSE) training program includes a manual and curriculum free of charge.

Competency Test Questions

Section I

- 1.) How many OR fires are estimated to occur in the United States each year?
 - a.) 50-100
 - b.) 100-200
 - c.) 200-300
 - d.) 550-650**

- 2.) Most fire claims occur in patients who receive which method of anesthesia during surgery?
 - a.) Regional Anesthesia
 - b.) Monitored Anesthesia Care (MAC)**
 - c.) General Anesthesia

- 3.) Which method of oxygen delivery has been shown to increase the risk of OR fires?
 - a.) Closed oxygen delivery via an endotracheal tube (ETT)
 - b.) Closed oxygen delivery via a laryngeal mask airway (LMA)
 - c.) Open oxygen delivery via nasal cannula or face mask**

- 4.) True or False: Electrocautery and electrosurgery are the most common ignition sources of operating room fires?
 - a.) True**
 - b.) False

Section II

- 5.) The “fire triangle” also known as the “fire triad” is made up of which three components?
 - a.) Ignition sources, drapes, and alcohol prep solution
 - b.) Upper body procedures, electrocautery, and oxygen
 - c.) An oxidizer, an ignition source, and a fuel**
 - d.) A fuel, drapes, and an ignition source

- 6.) True or False: Each member of the surgical team should only be responsible for the fire hazards that are present on their side of the fire triangle?
 - a.) True
 - b.) False**

- 7.) The atmosphere around a patient is considered an oxygen-enriched atmosphere (OEA) if it contains more than ____ oxygen.
 - a.) 17%
 - b.) 21%**
 - c.) 30%

- d.) 50%
- 8.) Which of the following is **NOT** an oxidizer?
- a.) Oxygen
 - b.) Carbon dioxide (CO₂)**
 - c.) Nitrous Oxide (N₂O)
- 9.) Chemicals (such as alcohol based prep solutions), drapes, dry sponges, and body hair are examples of which element of the fire triangle?
- a.) An oxidizer
 - b.) An ignition source
 - c.) A fuel**
 - d.) None of the above
- 10.) ChloraPrep and DuraPrep contain up to 70-75% isopropyl _____ and should be allowed to dry at least three minutes prior to surgical draping in order to prevent surgical fires.
- a.) Iodine
 - b.) Betadine
 - c.) Soap
 - d.) Alcohol**
- 11.) Intestinal gases can ignite because they are composed of various concentrations of methane, hydrogen, and oxygen. Anesthetic delivery of _____ can diffuse into the bowels, possibly making intestinal gas more flammable.
- a.) Carbon dioxide (CO₂)
 - b.) Sevoflurane
 - c.) Nitrous Oxide (N₂O)**
 - d.) Desflurane
- 12.) Which electrocautery method is more likely to cause a fire in an oxidizer-enriched environment?
- a.) Monopolar**
 - b.) Bipolar
 - c.) Tripolar
- 13.) True or False: Fiberoptic light sources are sometimes called “cold light” and are therefore not capable of causing ignition?
- a.) True
 - b.) False**
- 14.) Which of the following is not an ignition source?
- a.) Lasers
 - b.) Electrosurgery devices
 - c.) Defibrillators
 - d.) Gastrointestinal gases**

Section III

15.) True or False: The new fire prevention recommendations focus on eliminating delivery of 100% oxygen via nasal cannula or face mask during high risk procedures?

- a.) **True**
- b.) False

16) Which is appropriate for the patient who requires 100% oxygen for head or neck surgery?

- a.) **Secure the airway with an ETT**
- b.) 100% oxygen via face mask at 5 L/min
- c.) 100% oxygen via nasal cannula at 2 L/min

17.) Recommendations for minimizing fuel source risks include all the following **EXCEPT**:

- a.) Avoid pooling or spilling of flammable liquid preps..
- b.) Allow flammable liquid preps to dry before draping.
- c.) Remove towels which have absorbed flammable prep solutions.
- d.) **Keep drapes and fenestration towel edges as close to the incision as possible.**

18.) Recommendations for minimizing ignition source risks include all the following **EXCEPT**:

- a.) Use the lowest possible voltage necessary
- b.) Place the active electro-surgical device in a holster when not being used.
- c.) **The surgeon should have their assistant activate the electro-surgical unit when the surgeon is using it.**
- d.) The surgeon should activate the unit only when the active electrode tip is in direct view, especially if looking through a microscope or endoscope.

19.) Recommendations for minimizing fire risks during laser surgery include all the following **EXCEPT**:

- a.) Limit the laser output to the lowest clinically acceptable power density and pulse duration.
- b.) Test-fire the laser onto a safe surface (such as a laser firebrick) before starting the surgical procedure to ensure that the aiming and therapeutic beams are properly aligned.
- c.) Use appropriate laser-resistant tracheal tubes during upper-airway surgery.
- d.) **Keep the laser in active mode while removing it from the surgical site.**

20.) Recommendations for minimizing fire risks during surgery with fiberoptic light sources include all the following EXCEPT:

- a.) Be aware that fiberoptic light sources can start fires.
- b.) Complete all cable connections after activating the light source.**
- c.) Never place active fiberoptic cables on drapes or other flammable materials.
- d.) Place the fiberoptic light source in standby mode, or turn the light source off, when disconnecting cables.

21.) During the Fire Risk Assessment Score, one point is awarded for each of the three major risk factors. Which of the following is **NOT** a major risk factor for the Fire Risk Assessment?

- a.) Use of an open oxygen source (that is, the patient is receiving supplemental oxygen via any variety of face mask or nasal cannula).
- b.) Use of medical grade air.**
- c.) Presence of an ignition source such as an electrosurgery unit, laser, or fiberoptic light source.
- d.) Procedure at or above the level of the xiphoid process.

22.) A Fire Risk Score of 3 indicates what category of fire risk?

- a.) Low fire risk
- b.) Low fire risk with potential to convert to high risk (intermediate-risk)
- c.) High fire risk**

23.) The major changes that are being advised for head, face, neck, and upper-chest surgeries include all EXCEPT:

- a.) As long as a spontaneously breathing, sedated patient can maintain their blood oxygen saturation without extra oxygen, use only air for open delivery to the face.
- b.) If the patient cannot maintain safe blood oxygen saturation without supplemental oxygen, then the airway should be secured by using a LMA or tracheal tube, so that oxygen-enriched gases do not vent under the surgical drapes.
- c.) The traditional practice of open delivery of 100% oxygen should be discontinued (with limited exceptions).
- d.) It is important to remember that, for surgery locations not in proximity to an oxygen source, open delivery of oxygen can be used, and the risk of fire is not present.**

24.) True or False: Exceptional cases are surgical procedures around the head, face, neck, and upper chest where conscious sedation is required and oxygen delivered by nasal cannula or mask may be necessary to maintain adequate blood oxygen saturation.

- a.) True**
- b.) False

25.) When delivering oxygen in exceptional cases, restricting the oxygenation concentration to ___ % or less will minimize the fire risk and may provide an acceptable oxyhemoglobin saturation.

- a.) **30**
- b.) 50
- c.) 60
- d.) 70

26.) Three options for blending oxygen with air during exceptional surgical cases where open oxygen delivery is essential include all the following EXCEPT:

- a.) Air-oxygen blender
- b.) Blended gas directly from a common gas outlet on a three gas (air, oxygen, and N₂O) anesthesia machine.
- c.) **Use auxiliary oxygen flowmeters which are only capable of delivering 100% oxygen.**
- d.) Blended air and oxygen via the patient wye on the anesthesia breathing circuit.

27.) True or False: Regardless of which open oxygen delivery method used during exceptional cases, if you first deliver 100% oxygen with the intent of later lowering the oxygen concentration prior to using an ignition source, it may require several minutes to reduce the oxygen concentration delivered to the patient and accumulating under the drapes?

- a.) **True**
- b.) False

28.) Allow at least ____ minutes for alcohol based prep solutions to dry.

- a.) 1
- b.) **3**
- c.) 10
- b.) 15

29.) Scavenging the operating field with suction or flushing the field with medical air will _____ oxygen buildup at the surgical site.

- a.) Increase
- b.) **Decrease**
- c.) Not change

30.) True or False: Use of an adherent incise drape and assembling surgical drapes in a manner that minimizes oxygen buildup underneath the drapes will help to decrease operating room fires?

- a.) **True**
- b.) False

31.) If an ignition source is used in a high-risk procedure the surgeon should give the anesthesia provider adequate notice (___ to ___ minutes) before activation of the ESU or other ignition source, so that oxygen concentration can be reduced to less than 30% and nitrous oxide can be discontinued.

- a.) **3 to 5**

- b.) 6 to 8
- c.) 10 to 12
- d.) 15 to 17

32.) Strategies to prevent fires during procedures that take place in the airway include all the following **EXCEPT**:

- a.) Use of a cuffed endotracheal tube
- b.) The oxygen concentration should be reduced to less than 30%, and nitrous oxide discontinued
- c.) Use suction with a metal cannula deep within the oropharynx to scavenge the gases from an intubated patient.
- d.) Keep all sponges and gauze dry throughout the procedure to decrease the likelihood of ignition.**

33.) Which the following recommendations about fire safety during a tracheostomy are **NOT** true:

- a.) Use electrosurgery or electrocautery to cut into the trachea.**
- b.) Use a scalpel or scissors to enter the trachea.
- c.) In cases where electrocautery is necessary to secure hemostasis, and high oxygen concentrations are unavoidable, flooding the surgical field with a carbon dioxide cannula can prevent fires from occurring.
- d.) Poor communication between the surgeon and anesthesia provider are often the cause of fire during tracheostomies.

34.) True or False: Pulmonary blebs and other lung abnormalities can cause leakage of anesthetic gases onto the surgical field during chest cavity surgery?

- a.) True**
- b.) False

Section IV

35.) What are some **early** warning signs of a fire?

- a.) Smelling smoke
- b.) Hearing a “pop”
- c.) Seeing a flash
- d.) Seeing the surgical drapes on fire
- e.) all of the above
- f.) a, b, and c**

36.) True or False: Retrieving a fire extinguisher should be the first response to a surgical fire?

- a.) True
- b.) False**

37.) The **initial response** to a surgical fire on the patient should be to:

- a.) Retrieve a fire extinguisher

**b.) Immediately announce the fire and initiate fire management tasks
→ efforts are focused toward stopping the burning process and
removing the fire source.**

c.) Call 911

d.) Shut off the gas supply to the room

38.) If the fire is not immediately extinguished after the first attempts, use a _____ fire extinguisher to put out the fire.

a.) Water

b.) Dry Chemical

c.) Carbon Dioxide (CO₂)

39.) At the first sign of fire in the airway, tracheal tube, or breathing circuit, all the following should be done EXCEPT:

a.) Immediately and simultaneously disconnect the breathing circuit from the tracheal tube and remove the tube. Flow of airway gases should also be stopped at the same time.

b.) Have another team member extinguish any items that were taken out of the patient's airway.

c.) Pour saline or water into the airway to ensure that any remaining embers are extinguished and to cool the tissues.

d.) Resume ventilation with 100% oxygen.

40.) The patient should be evacuated if the room is dangerous from smoke or fire. What are the four components of the **RACE** fire evacuation protocol?

a.) Rescue, Alarm, Confine, Extinguish

b.) Run, Alarm, Comfort, Evaluate

c.) Rescue, Alert, Comfort, Extinguish

d.) React, Aim, Confine, Elevate

41.) Management of the patient after the fire is controlled includes all the following EXCEPT:

a.) Perform a thorough, full-body assessment for burn injuries

b.) Apply a dry sterile dressing to injured areas.

c.) As long as a patient with inhalation burn injury is initially stable there is no need to keep the patient overnight for observation.

d.) Transfer patients who meet the American Burn Association's criteria for major burns to a burn center.