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# It's Only a MAC Case and Now My Patient is on FIRE!

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## Stem Case and Key Questions Content

A 68 year old male is scheduled for wide local excision of a melanoma from his right anterior chest under monitored anesthesia care (MAC) anesthesia. He has a history of hypertension, anxiety, type II diabetes mellitus, and COPD. He has a 40 pack/year smoking history and currently smokes one pack of cigarettes per day. He drinks one to two cocktails daily and two to three glasses of wine nightly. Medications include metformin, enalapril, xanax, and albuterol inhaler. Previous surgeries include lumbar laminectomy and inguinal hernia repair. He has had no problems with anesthesia in the past. Preoperative labs are unremarkable. In the preoperative evaluation clinic his vital signs were BP 155/90, HR 82, R 16, and $SaO_2$ 94% on room air. Physical examination: Airway: Mallampati II, neck FROM, teeth intact; Cardiac exam: regular rate and rhythm without murmur: Pulmonary exam: mild expiratory wheezing.

**1. Is MAC anesthesia appropriate for this patient?**
**2. What problems do you anticipate in relation to his COPD?**
**3. What problems do you anticipate in regards to his anxiety and alcohol consumption?**

The patient is placed on the operating room table. Standard ASA monitors are applied. Oxygen is begun at 3 liters/ minute via a nasal cannula with $ETCO_2$ sampling capabilities. He is administered midazolam incrementally to 3 mg. He is administered fentanyl 100 micrograms. Surgical prep is performed with a chlorhexidine and alcohol based prep solution. Surgical draping is performed. The patient is administered 50 mg propofol while the surgeon is injecting the surgical site with local anesthesia. At this time the nasal cannula oxygen is increased to 4 liters/minute. Surgery is begun. The surgeon picks up the electrocautery device to control bleeding edges of the surgical incision. Upon activation of the electrocautery there is the sudden appearance of smoke, followed immediately by visible fire which quickly engulfs the surgical drapes and the patient's chest, head and neck.

**1. What are the immediate steps to take at this time?**
**2. What factors have contributed to the occurrence of this fire?**
**3. What are the components of the fire triangle in this case?**
**4. What could have been done to prevent this fire from occurring?**

The surgeon calls for a basin of water, but none is immediately available. The anesthesiologist quickly stops the flow of oxygen through the nasal cannula. The surgical drapes are quickly

removed and thrown on the floor and extinguished. The patient is noted to have second and third degree burns on the chest, head and neck.

**1. What are the appropriate steps to take in extinguishing an on-patient fire in the OR?**
**2. What are the types of fire extinguishers, and what types can be used on a burning patient?**
**3. What is the next course of action? Should general anesthesia be induced?**
**4. What is the appropriate institutional reporting and follow-up?**

**Model Discussion Content**

Surgical fires are a serious and potentially catastrophic event in the operating room. It is estimated that there are 550-600 surgical fires in the United States each year.[1] A number of patients suffer severe burn injuries, and several patients die each year from burn injuries incurred in the operating room. Fires occur on the body or in the airway during surgical procedures in the airway. Fires during procedures in the head and neck area, especially done under monitored anesthesia care (MAC) anesthesia are felt to be the most frequently occurring today. [2] This discussion will focus on fires occurring on the patient.

Much attention has been directed over the last several years toward educating anesthesiologists, nursing personnel, and surgeons regarding the risks of surgical fires and means of preventing them. In 2003 the Joint Commission published a sentinel event alert: Preventing Surgical Fires. In 2005 the AORN published a Position Statement on Fire Prevention. In 2008 the American Society of Anesthesiologists published a Practice Advisory for the Prevention and Management of Operating Room Fires which was updated in 2013. This was designed to provide information to help prevent operating room fires, and identify the proper response to an operating room fire. The American College of Surgeons has conducted educational sessions on surgical fire prevention at its annual meeting. The FDA and partners have introduced the “Preventing Surgical Fires” initiative. The Anesthesia Patient Safety Foundation has published a Fire Prevention Algorithm as well as an educational video. Yet despite these efforts, surgical fires continue to occur. When considered in light of the 50-60 million surgeries performed each year, surgical fires are relatively rare. However, when surgical fires occur, the results can be devastating with disfiguring burn injuries, psychological trauma, medical malpractice litigation, and death. Continuing education efforts are warranted in order to decrease the incidence of these events.

In order for a fire to occur, three factors must be present. These are an oxidizer, an ignition source and fuel. Together these constitute the three components of the fire triangle. Elimination of one component of the fire triangle greatly reduces the risk of fire.

Oxidizers are oxygen and nitrous oxide. An oxygen enriched atmosphere increases the likelihood and intensity of combustion. An oxygen concentration greater than 21% produces an oxygen enriched atmosphere. Many materials that are not susceptible to combustion in room air will burn in an oxygen enriched atmosphere. Oxygen enriched atmospheres lower the

temperature at which fuels ignite and allow fires to spread faster.[3] Oxygen can be delivered via nasal cannula, face mask, laryngeal mask airway, or endotracheal tube. The risk of fire is higher when a nasal cannula or face mask is used to deliver oxygen. Oxygen is heavier than air and so will settle in low lying areas such as beneath surgical drapes. Nitrous oxide mixed with oxygen is also an oxygen enriched environment. Fire liberates oxygen from nitrous oxide allowing it to support combustion. The risk of fire with a nitrous oxide-oxygen mixture is considered equivalent to a 100% oxygen environment.[4]

The second component of the fire triangle is an ignition source. The most common ignition source in the operating room is the electrosurgical unit (ESU). Other ignition sources include lasers, heated probes, drills and burrs, and fiberoptic light sources.

The third component of the fire triangle is a fuel source. Fuel sources include anything that can burn. The most common fuel sources are surgical drapes, gowns, sponges, linens, and dressings. Other fuel sources include nasal cannulas, face masks, blood pressure cuffs and the patients' hair. Alcohol containing surgical prep solutions are also a fuel source and can ignite. Each member of the surgical team controls a specific side of the fire triangle. The surgeon controls the ignition source. The nurse controls the fuel. The anesthesiologist controls the oxidizers.

**Prevention of Surgical Fires**

All members of the surgical team are responsible for preventing surgical fires and need to be proactive in taking proper precautions to see that the risk of surgical fire is minimized as much as possible.

Communication among the members of the OR team is critically important in lessening the risk of surgical fires. During MAC cases, especially cases involving the head and neck areas, it is important to keep the $FiO_2$ as low as possible. A patient receiving oxygen 2 liters/minute by nasal cannula via the auxiliary flow meter on an anesthesia machine is receiving less than 30% alveolar inspired oxygen. However, 100% oxygen is flowing from the nasal cannula and can accumulate under the drapes. Mixing air and oxygen to keep the $FiO_2$ less than 30% delivered to the patient and the operative site is desirable and will lessen the risk of a fire occurring.[5] If possible no supplemental oxygen during MAC cases is recommended. If a patient requires a large amount of sedation to tolerate the surgical procedure, and thus requires significant supplemental oxygen to maintain $SaO_2$ greater than 90%, then a general anesthetic utilizing a laryngeal mask airway or endotracheal tube is recommended.

The surgeon and anesthesiologist must communicate. The surgeon must know what oxygen supplementation is being given to the patient. The anesthesiologist must know when the surgeon is going to use the ESU. Oxygen must be reduced or turned off for several minutes before the surgeon plans to use the ESU. This allows the accumulated oxygen to dissipate. In draping the patent for the procedure, the surgeon should place the drapes to lessen the chance of oxygen accumulating under the drapes.[6]

Of the surgical fires reported to the Emergency Care Research Institute (ECRI), in approximately 70% the electrosurgical unit was the ignition source.[7] This can occur when the ESU is activated in an oxygen enriched atmosphere. Ignition can also occur when the device is activated inadvertently while placed in contact with the surgical drapes. Whenever the ESU is not being used it should be placed in a holster away from the surgical site. The ESU should only be activated by the person using it. It should only be activated when the tips are in view and deactivated before removal from the surgical site. There have not been any fires reported with use of a bipolar ESU.[8] This is likely due to the low power and lack of arcing at the tip of the bipolar forceps. Having a basin of water or saline on the sterile field is recommended for any case in which an ESU is being used so that it can be immediately accessed to douse flames. Fiberoptic light sources collect incandescent light energy and direct it into an optical fiber. Fiberoptic light sources can produce hundreds of watts of light power. This can ignite a fire. Steps should be taken to lower the risk of fire with fiberoptic light sources. All cable connections should be completed before activating the source. The light source should be placed in standby or turned off before disconnecting. A fiberoptic light source or light cord should never be left in close proximity to surgical drapes while still turned on.[9]

Minimizing fuel sources and being careful with them is essential in lowering the risk of surgical fires. Alcohol containing prep solutions should be given several minutes to completely dry before surgical draping is performed in order to allow vapors to disseminate. Care should be taken that the prep is not sloppy such that pools of prep solution accumulate around the patient. These pools take longer to dry and evaporate and thus increase the risk of fire.[10]

Using moist or wet sponges during high risk procedures is recommended, taking care to insure they do not dry out during the procedure. During head and neck procedures it is suggested to coat exposed hair with a water soluble lubricating jelly to make it nonflammable. Using surgical gowns and drapes that resist combustion is also advised.

The Anesthesia Patient Safety Foundation has produced a fire prevention algorithm to assist clinicians in making decisions in cases in which a patient may be at risk for surgical fire.[11] The algorithm recommends room air sedation if the patient is at risk for surgical fire. If oxygen supplementation greater than 30% $FiO_2$ is required then the recommendation is made to secure the airway with an endotracheal tube or supraglottic airway device.

It is recommended that members of the surgical team discuss the procedure before the case in order to assess the risk of surgical fire. If a procedure is determined to be at high risk then a discussion should be held to determine what steps are being done to prevent a fire occurring and what to do in the event of a fire. The ASA Practice Advisory recommends that every anesthesiologist have knowledge of institutional fire safety protocols for the OR and that they should participate in OR fire safety education. The practice advisory also states that anesthesiologists should participate in OR fire drills with other members of the OR team.[12]

**Managing an On-Patient Fire in the Operating Room**

Prevention is the only effective cure for surgical fires. However if a surgical fire occurs, having a prepared and trained team is essential in keeping a serious event from escalating into a potentially catastrophic event. Managing an on-patient fire involves several steps: 1.recognizing early signs of fire, 2. stopping the procedure, 3. taking steps to extinguish the fire, 4. evacuating if necessary, and 5. providing post-fire care to the patient.[13]

A fire may be preceded by odors, smoke, a flash or unusual sounds. If these are seen, smelled or heard, then serious attention should be directed to discovering the source and stopping further progression. If a fire occurs, the procedure must be halted immediately. An announcement of fire should be made. The flow of all airway gases should be stopped. Burning drapes should be removed and thrown on the ground and extinguished. Remaining fire should be extinguished with water or saline. If necessary a $CO_2$ fire extinguisher should be used. If the fire persists after use of the fire extinguisher then activate the fire alarm and evacuate the patient if feasible. Close the door to the room and do not reopen it or enter the room. Shut off the medical gas supply to the room. As can be seen from these steps, having a plan in place will allow the fire to be managed in a stepwise fashion. Having practiced fire drills previously will ensure team members know their roles as well as the location of fire extinguishers and medical gas supply controls.[14]

As quickly as possible, the patient should be assessed for burn injury, as well as inhalational injury if they were not intubated at the time of fire. Appropriate steps should be taken to address the patient's injuries. If the patient is under MAC anesthesia, consideration will need to be given to inducing general anesthesia for treatment of burn injury and intubation for airway protection if inhalational injury is suspected.

The event should be reported according to local regulatory requirements. Institutional protocols should be followed in treating the fire as an adverse event. The hospital risk management office should be notified.

Surgical fires are serious, potentially fatal events. They are preventable. Proper education, training and understanding of the fire triangle should make surgical fires extremely rare events. Participation of the entire surgical team in OR fire safety education and fire drills should lessen the severity should a fire occur.

The Anesthesia Patient Safety Foundation in association with The ECRI Institute has produced an 18 minute video: Prevention and Management of Operating Room Fires. This can be viewed on the APSF website www.apsf.org. A complimentary copy can be ordered on the website.

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