Acknowledgements

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**Purpose**
The purpose of this course is to provide the knowledge and the tools that the perioperative nurse will need to practice effective fire safety in any surgical setting.

**Learning Objectives**

After successful completion of this course, you will be able to:

1. Identify the reasons for an increased risk related to surgical fires.
2. Describe factors that prevent staff from reporting fires.
3. Describe goals of The Joint Commission Sentinel Event Policy.
4. Identify the greatest contributing factor reported in surgical fires.
5. Identify the three components in the fire triangle.
6. Identify the roles and responsibilities of each member of the surgical team in preventing fires.
7. List fuels that are commonly found in the surgical setting.
8. Identify heat sources which can create a fire hazard.
9. Explain how oxygen-rich environments are created.
10. Outline steps to treat a fire when fire exists.
11. Identify the roles and responsibilities of hospital leadership in preventing surgical fires.
12. Name the four components of the acronym “R.A.C.E.”.
Introduction

Surgical fires are rare events that have devastating consequences (Allen, 2011. Malone, 2010.). Every year patients and their families suffer through the tragic consequences of preventable injury (Health Devices, 2009). Imagine sending a loved one into surgery believing the medical team will improve their condition only to have them emerge disfigured.

Incidence

ECRI* estimates that there are roughly 600 surgical fires per year inside the United States. Of those only 20 to 30 result in “disfiguring or disabling Injuries”, and only one or two are fatal (Surgical Fires, 2011).

If surgical fires are 100% preventable, the families and patients that ultimately suffer from a surgical fire, would likely agree that even one death is too many (Surgical Fires, 2011).

*Note that the ECRI Institute is an independent, nonprofit organization that researches the best approaches to improving safety, quality, and cost-effectiveness of patient care (ECRI Institute, 2011).

Surgical Fires as Never Events

According to The Joint Commission (TJC), surgical fires meet criteria to be termed “never events” because they are preventable if healthcare providers take appropriate steps to protect patients. All surgical fires can result in considerable injuries or even death of patients, and thus should never occur (Surgical Fires, 2011. Suchetka, 2010).
Reporting Surgical Fires

While the risk of surgical fire has been around nearly as long as surgery itself, the reporting of surgical fires remains relatively less well established (Kohut, 2006).

The first formal reporting of surgical fires dates back to 1850. This fire erupted during a facial procedure using both ether and hot cautery.

Current reports of surgical fires are not too dissimilar in that the basic components of fire are still the same.

An Unfortunate Event

In 2009 a surgical fire was reported in the Internet Journal of Anesthesiology. The unfortunate events occurred during the procurement of organs from a nineteen year old male donor (Herman, 2009). The young male lost his fight for life three weeks after complications from a motor vehicle accident. His family, in an effort to turn an otherwise desperate situation into something more positive, requested that his organs be donated. What unfolded next had potential consequences for not only the young man’s family, but also those now anxiously awaiting recipients.

At the start of the procedure, the surgeon cleaned the surgical site with a product commonly used in surgical procedures which includes iodine povacrylex and nearly 75% isopropyl alcohol. Because the part of the patient’s history included sepsis and there was visible discharge from the tracheotomy site, the surgeon wrapped an alcohol soaked sponge around the tracheotomy tube and left it in place during the procedure.

Nearly immediately after the procedure began flames erupted from the patient. The team was able to extinguish the flames with a saline bag of fluid and some ice chips, having failed their initial attempt with a towel, but the damage was already done. The patient now had burn injuries extending over the face, neck, and shoulder covering an area 5 inches wide and 10 inches long.

Fortunately, the event did not prevent the donation process from moving forward, nor did the young man suffer from injuries sustained in the fire. Unfortunately, it took this dramatic event to illustrate the need for diligence when it comes to preventing surgical fires (Herman, 2009).
The Fire Triangle

The fire triangle consists of 3 components (Health Devices, 2009):

1. Heat
2. Fuel
3. An oxidizer (oxygen)

If any of the three components are not present, then a fire cannot occur. If any of the three elements is significantly reduced, the risk for fire is reduced.

Prevention efforts starting from each of the three categories must be reviewed and practiced routinely in order to ensure a safe patient environment (AORN, 2008).
The Role of the Surgical Team in Fire Prevention

The entire surgical team plays an important role in fire prevention (Health Devices, 2009) and it is important for each team member to understand how their role in the surgical procedure can contribute to the fire triangle.

While each member of the team performs their specific role in the operating room, their activities can interact with the activities of other team members and increase the fire risk.

Imagine a three-legged stool. If one leg is missing it cannot stand. Just like the stool, there are three parts to a surgical team that must come together in order to produce a result.

Understanding how the role and activities of the surgeon, the nurse, and the anesthesia provider can interact can prevent the deadly consequences of a surgical fire (Health Devices, 2009).

Taking Sides

The surgeon is most frequently responsible for the ignition sources. They apply electrocautery, direct lasers, and fiber optic light sources.

Anesthesia providers supply the oxidizers including oxygen, nitrous oxide, and medical compressed air.

Nurses are often responsible for the fuels; including prepping agents, drapes, sponges, and gowns (Ouellette, 2011).
Taking Ownership

It is the responsibility of each of these key team members to not only manage their side of the triangle, but also to articulate the potential interactions their product or device has with the rest of the team (Ouellette, 2011).

Communication is an important part of surgical fire prevention.

Heat and Ignition Sources

If you want to drive a car, you need a key to start it. Heat serves as a catalyst (key) to increase the oxidation rate of the fuel/oxygen mixture until a state of combustion is achieved. The following are a few catalysts that would work:

- Electrosurgical units (ESU)
- Fiber optic light sources and cables
- Lasers
- Drills and burrs
- Argon beam coagulators
- Overhead lights

The tip of an electrocautry pencil can maintain heat even after the device is deactivated. A surgeon or assistant can activate the ESU via a misplaced footpedal.

A light cable left illuminated on the surgical drapes, or a cable that has been turned off after prolonged use can retain heat and ignite a fire within minutes.

Sparks can be created by drill bits, burrs, or touching an ESU (Electrosurgical Unit) pencil to an instrument (AORN, 2008).
Fuels

There are multiple fuel sources used routinely in an operating room.

Virtually everything that comes into contact with the patient (including the patient’s own hair) is flammable (AORN 2008).

Fuel is anything that can burn (Smith, 2004). A fire can start when a fuel becomes so hot that it releases sufficient flammable gases for combustion to occur (Smith, 2004).

Examples of Fuels

<table>
<thead>
<tr>
<th>Examples of Fuels</th>
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<tbody>
<tr>
<td>Bone cement that creates fumes during mixing</td>
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<tr>
<td>Materials like dressings, sponges, and drapes</td>
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<tr>
<td>Plastic and rubber, including anesthesia circuits, endotracheal tubes, masks, and gloves</td>
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<tr>
<td>Solutions and ointments, such as chlorhexidine or alcohol</td>
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<tr>
<td>The patient’s body or facial hair, perfume, or gastrointestinal methane gas</td>
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Alcohol-Based Surgical Scrubs

A relatively new product introduced to the surgical arena includes alcohol based surgical scrubs, used by the surgical team to wash their hands prior to surgery. More traditional surgical scrubs took place over a sink and included a scrub brush and water.

Like prepping solutions it is important that these products dry completely before donning gloves or gowns.

An alcohol based hand scrub can increase the risk of a surgical fire starting on a member of the scrubbed surgical team. Protecting the staff from surgical fire is just as important as protecting the patient (Smith, 2004).

Oxygen

Fires cannot occur without sufficient oxygen. The more oxygen available in an environment, the less heat required to ignite the fuel (Smith, 2004).

Fires in an oxygen-rich environment are harder to put out, move much faster, and create more heat.

Nitrous oxide contains oxygen and can promote combustion as well (Herman, 2009).
Prevention

In November of 2010, ECRI listed Surgical Fires among the top ten Technology Hazards expected for 2011. ECRI identified that “virtually all surgical fires can be avoided.”

ECRI went on further to say that training and drills for preventing and extinguishing fires was a must have for organizations that are serious about preventing fires (Top Ten, 2010).

AORN identified in 2008 that fires can occur in operating rooms, ambulatory suites, physician’s offices, procedural areas and endoscopy suites (AORN, 2008).

According to AORN, “Fire is an ever-present danger and poses a real hazard to patient and healthcare worker safety” (AORN, 2008).

Prevention Programs

Effective prevention programs include all professionals involved in the care of the surgical patient.

A multidisciplinary approach to fire prevention encourages active communication between team members (AORN, 2008).

Team members must understand how their routine responsibilities during a procedure can feed, ignite, or support a surgical fire.
Communication as a Preventative Measure

It is the responsibility of all staff to communicate between sides of the triangle when the risk for fire is present. They should know what part of the triangle they can control (Health Devices, 2010).

A surgeon may need to tell the anesthesiologist when they plan to use the ESU pencil so that an oxygen-rich environment can be reduced.

A nurse may need to tell a surgeon that the surgical prep is not dry, before they activate a pencil.

Knowing what is happening on the other side of the triangle is a key to preventing fires.

Designing a Fire Safety Program

When designing a fire safety program the following topics should be included or strongly considered (Health Devices, 2010. AORN, 2008):

- Fire drills
- The use of firefighting equipment
- The location gas shut off valves
- Methods for fighting fires
- Evacuation routes
- Locations of ventilation, gas plumbing and electrical systems within the department
- Location of extinguishers and fire alarms
- Procedures for calling the fire department
- Procedures for reporting fires and near misses
**Prevention Training Programs**

Training programs should also take into account those practitioners that may only practice in the environment for a limited time period.

Program materials must be available for students, residents, fellows and others, that may only enter the operating theater for a few days, weeks or hours.

Guests to a practice setting should be provided with brief introduction to a unit including key elements of emergency procedures (AORN, 2008).

**Avoiding Complacency**

Human complacency should also be considered an important undesirable and preventable segment in the fire triangle, and should perhaps be located at the center of it all.

In order to prevent surgical fires, the team must first realize that the danger is real and an attitude of “it can’t happen to me” can put them and their patients in harm’s way (Smith, 2004).

Vigilance is the key to reducing the risk of fire.

Each team member can play a specific role in reducing the risk of fire.
The Role of the Nurse

Nursing staff manage the majority of the fuels that are used during a procedure. The following are a list of interventions that nurse can deploy to help mitigate the risk of fire (Health Devices, 2009):

- Meticulous prepping technique should be employed to avoid the pooling of prepping solutions.
- The skin prep should be allowed to dry prior to draping and the drapes should be placed in such a way as to avoid tenting.
- Water soluble ointments should be used wherever possible since petroleum-based products are flammable.

When multiple foot pedals are required, each foot pedal should be placed in position during its use and removed when finished to avoid inadvertent activation of the wrong foot pedal at the wrong time.

Equipment should be well maintained by the bioengineering department and inspected prior to use.

An ESU holster must be used to avoid inadvertent activation of the pencil.

Remember above all, you are a patient advocate.
The Role of the Surgeon

The surgeon is especially responsible to prevent fire because he or she controls the heat or ignition sources during surgery.

Heat sources include lasers, electrocautery, as well as lights sources. In addition, the surgeon must be alert to equipment that can create heat when used for extended time periods.

Mechanical devices such as drills and burrs can generate heat, or create sparks if they come in contact with other instruments.

Certainly, the practice of touching the ESU pencil to a clamp to seal a vessel can be particularly dangerous. Such practice can create an arch spark a fire.

While replacing the ESU back in the holster may be seen as an inconvenience, the surgeon must strongly encourage that the practice is followed. Putting out a fire would prove to be far more inconvenient.

Similarly, good communication related to light sources can be critical. A light source left unattended on the drapes can have devastating results. The surgeon should communicate to the nursing staff when a light source may not be needed, or when it could be removed from the surgical field.
The Anesthesia Provider

The anesthesia provider is responsible for the oxidizers in the form of oxygen and nitrous oxide.

- Laser appropriate endotraecheal tubes should be used during ENT laser procedures and oxygen concentrations of 100% should be avoided.
- All oxygen requirements should be maintained at the lowest levels possible in order to support the patient’s oxygenation but still minimize the creation of an oxygen-enriched environment.

Active communication between the surgeon and the anesthesia provider should occur to temporarily discontinue oxygen and nitrous oxide sources at critical times during the procedure.

According to a report from ECRI and the Anesthesia Patient Safety Foundation, “Fires in oxygen-enriched atmospheres ignite much more easily, burn hotter, and spread more quickly” (ECRI Institute, 2001a). Thus, the anesthesia provider also plays an important role in reducing the risk of fire.
The Drill

Planning a fire drill requires the coordination and expertise of the surgical team as well as close collaboration with risk management, and the organization’s safety officer (AORN, 2008).

Independent observers also serve a valuable function in assessing the performance of the team while the drill is in progress.

Fire drills should be conducted a minimum of one to two times per year.

All team members should participate in a post fire drill debriefing to formally evaluate successes and opportunities for improvement.

AORN indicates that a fire drill could take several months to coordinate, according to a guidance statement released in 2008 (AORN, 2008).

A fire drill is an opportunity for learning about fire prevention (AORN, 2008). Appendixes A and B provide sample drill evaluation forms and a drill record.

The drill must include hands on practice of all activities that would be performed during a surgical fire.

Talking through the steps one might follow during a drill, or writing down an evacuation plan are helpful, but should be used as a supportive teaching tool rather than a single modality.

Members of the surgical team must have the opportunity to manipulate materials, provide patient care, direct an evacuation, and use equipment in a manner that most accurately resembles their activities if there was a real fire.

A well-rehearsed plan can help people understand more clearly their role in a surgical fire.
R.A.C.E

The acronym of R.A.C.E. is used to help providers remember their immediate responsibilities in the event of a fire (AORN, 2008).

R.A.C.E. stands for the following:
- Rescue the individual that is involved in the fire.
- Alarm should be sounded as soon as possible.
- Confine the fire.
- Extinguish the fire and evacuate if required.

Extinguish: You Are the Firefighter

While reviewing R.A.C.E., the team will need to identify those occasions when it would be important to extinguish the fire first. You would certainly need to extinguish if the fire was on or in the patient. Thus the word rescue should be concentrated on removing those individuals in immediate danger from the fire.

Extinguishing the fire may require more than a bowl of water from the surgical field and in some cases, a fire extinguisher may be required.

Classes of Extinguishers

In the event that a fire extinguisher is required, staff will need to recognize that there are different extinguishers for different types of fires. Selecting the correct extinguisher will be just as important as understanding how to activate it.

There are three classes of extinguishers (Ouellette, 2011):
1. Class A: For fires involving wood, paper, cloth, most plastics, and other commonly flammable solids
2. Class B: For fires involving flammable liquids
3. Class C: For electrical energized fires
CO₂ Extinguishers

In the operating room, ECRI recommends a CO₂ extinguisher. CO₂ extinguishers expel a fog of cold gas and snow that leaves no residue as it cools the fire. CO₂ extinguishers are Class BC and are effective in flammable liquids and electrical fires and have been shown to function well in Class A fires.

Class A extinguishers should be used only when there are no other choices. The fine powder that is expelled can be difficult to remove from a wound and can be an irritant to an airway or mucous membranes (Ouellette, 2011).

Practice Makes Perfect

As with any other steps in a drill, when possible staff members should have the opportunity to safely practice using an extinguisher under the direct supervision of the hospital safety officer and in collaboration with a local fire marshal.
The Acronym of P.A.S.S.

When the need exists to deploy a fire extinguisher the acronym P.A.S.S. is useful.

P.A.S.S. stands for (Smith, 2004):

P - Pull the pin
A - Aim the nozzle at the base of the fire
S - Squeeze the handle
S - Sweep the stream over the base of the fire

Know Your Options

Extinguishing the fire may not require the use of a fire extinguisher and extinguishing the fire may not always be your last step in the management of the fire event, as indicated by R.A.C.E.

Understand your options and know how to deploy those options using critical thinking to choose the best solution for your patient and the team.
“Fire”

In the event of a fire or during the drill, each member of the surgical team should be able to articulate the following steps:

1. Believe your eyes – it is really a fire (Smith, 2004).
2. Remove the drapes/burning material and douse any small fires with water from the back table.
3. Drapes should be removed horizontally to prevent flames from spreading to other draping materials (Smith, 2004).
4. Lower the inspired O2 concentration and discontinue the use of nitrous oxide.
5. Care for the patient.
6. Call for help, activate the alarm system and extinguish any remaining fire with an extinguisher if needed.
7. Inspect the patient and your surroundings for any remaining fire.
8. If the fire is not contained or extinguished, evacuate closing all doors on the way out, to delay the spread of fire to other areas (Ouellette, 2011).

Evacuation Routes

Evacuation routes should be clearly labeled throughout any organization and surgery is no exception.

While the organization can post an evacuation route and provide emergency lighting to assist during an evacuation, staff must be familiar with these routes.

During the drill, staff members should have the opportunity to traverse evacuation routes with equipment that they might need to take with them during a real fire.
**Know the Drill**

Pushing a stretcher or an OR table through an area in a drill may help staff identify potential barriers to a safe and efficient evacuation (Smith, 2004).

During a fire staff members may be required to operate gas shut-off valves. As part of the drill staff should be able to identify who can shut off a gas valve and when to do so (Smith, 2004).

**Conclusion**

Many safety hazards are present during surgical procedures and OR nurses must be diligent in protecting their patients from harm. Fire safety is a priority and nurses must be the leaders to ensure proactive fire safety programs are established and practiced by the entire surgical team. With proper training and staff vigilance virtually all surgical fires can be avoided.
References


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