

Fire in the OR: “All Hands-on Deck!”

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Abstract

In response to our recent OR fire, our institution initiated a safety review and quality improvement project regarding our emergency preparedness. Several major modifications have been implemented including an all hands-on deck approach to training, increased frequency of simulation exercises with OR safety and fire-fighting equipment, as well as inclusion into our surgical timeout process. Operating room fires are rare but potentially catastrophic with costly loss of resource and possibly life.

Keywords: OR Fire; Surgical fires; Patient injuries in the surgical theatre; Strategies to reduce fire risk; Emergency preparedness project

Introduction

This case report details a true operating room electrical fire emergency and details the response by the operating room staff in preserving both life and property. This preventable fire itself highlights the hazardous nature of the operating theater as well as the responsibilities when faced with such an emergency. Much focus has rightfully been given to preventing such instances but in the face of such emergencies only preparation and teamwork can prevent catastrophic outcomes. Anticipation and preparation therefore must remain an important element in the modern operating room prevention fire protocol. The measures we have implemented have led to immediate improvements in our teams' readiness for the next OR emergency.

Case Report

The case was scheduled as a routine elective laparoscopic sigmoidectomy for colon cancer. Pre-operatively there was no indication of anything out of the ordinary. Once general anesthesia was administered and the endotracheal tube secured, the patient was positioned in typical lithotomy position and prepped with DuraPrep applicators. Once all participants were gowned and ready the standard pre-operative timeout was conducted. During the colectomy, we found dense adhesions between the abdominal wall and the descending and sigmoid colon. Furthermore, when dissecting deep into the pelvis, the tumor was found to be firmly adherent to the urinary bladder. Dissection finally freed the neoplasm from the bladder wall but, given the circumstances, the integrity of the bladder wall was questioned. In the dimly lit confines of the laparoscopy suite, the circulating nurse dutifully organized a saline bladder irrigation set-up. Solution was gently instilled into the bladder which, showed no signs of extravasation. The surgical team set about the final tasks of removing the sigmoid colon. Suddenly, a horrible arching sound burst through the silence of the operating room and a bright white flame appeared from the base of the monitor. The fire itself couldn't have been more than a few inches tall but it bathed the darkened laparoscopy suite in brilliantly blinding light. Smoke and the horrible smell of plastic and circuitry smoldering filled the room. Without delay the nurse anesthetist cut-off the oxygen supply to the patient and began ventilating with room air. As the surgical team immediately stopped the operation, the circulating nurse activated the overhead lights and dashed for the fire extinguisher by the door. With a short blast from nozzle, the fire was extinguished seemingly as quickly as it had started. After ensuring the safety of the patient and all personnel in the room, we set about the task of examining the fire to ensure nothing would reignite.

As it turns out the root of the problem was quite evident and, unfortunately, quite preventable. While setting up the bladder irrigation equipment in the darkened room, the nurse had unknowingly hung the

large bag of saline irrigate from the monitor handle directly above its power transformer. As we irrigated the bladder all attention was directed towards detecting a leak in the bladder wall. No one had appreciated a steady leak from the bag itself directly onto the monitor's power source. The conductive saline solution had shorted out the power supply, tripping the breaker in the adjacent surge protector, but not before igniting a small, albeit terrifying, electrical fire.

The mere presence of an operating fire put into motion a series of events including intensive investigations, root cause analyses, and mandatory reporting. The case itself resumed with some delay and progressed surprisingly smoothly once the equipment was replaced. Thankfully the patient was not harmed throughout the ordeal and recovered from surgery without complication. The surgical team and the department at large, however, were left with a renewed appreciation for the risks of operating room fires and a dedication to improving our preparedness.

Discussion

There are more than 50 million surgeries performed in the USA each year, but only approximately 100 surgical fires, according to Emergency Care Research Institute (ECRI) and the FDA. Of these fires, 20 to 30 cause serious injury or disfigurement, and one or two are fatal [1]. It is thought that some fires are never reported for fear of litigation, therefore, other sources may report a higher incidence. These fires not only can cause physical harm to the patient, but they can also damage the healthcare organization.

A recent review of the malpractice claims in the American Society of Anesthesiologists Closed Claims revealed that claims associated with OR fires are more often paid than non-fire related claims. Data from the Joint Commission Sentinel Event Alert reveals that the most common ignition sources are the electrosurgical equipment (68%) and lasers (13%). The most common locations are the airway (34%) and the head and face (28%), while a high oxygen concentration contributed to the fire in 74% of cases [2].

In an operating suite, there are many items that can catch fire in

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an instant (oxygen tanks, alcohol preps, etc). In order to cause a fire there has to be a complete “fire triangle”. The triangle elements include: a heat source, a fuel source, and a high oxygen concentration. Perhaps the two required elements for a fire to occur and the ones which we can control the most are the igniting source and the volatile substance that allows the fire to start. In an operating room, there are multiple examples of both elements, and some of these can be controlled or minimized. Some other factors, however, are much more complicated. For example, gastrointestinal gases, especially hydrogen and methane are readily flammable and general surgeons deal with this on a daily basis. A recent example of an operating room explosion as a result of these gases emphasizes the need for caution and perhaps avoidance of cautery when entering the abdomen, especially when a viscus perforation is suspected [3].

Dealing with such an event first requires an adequate risk assessment. A simple assessment tool, and the one used in our facility, is the one developed by Christiana Care health system based in Newark, Delaware [4]. This risk stratification categorizes fire risk into Low, Low risk with potential to convert to high risk, and High risk, and it is based on the location of the wound, the usage of the ignition source (cautery, laser, etc), and the existence of an open oxygen source (face mask, nasal canula) (See attachment 1). Risk evaluation and stratification with documentation the fire risk before the case starts, is not only a tool to elevate the awareness of the OR team in high risk procedures, but can also serve as a reliable variable for future research and root cause analysis into this subject, which may ultimately lead to a reduction of these unfortunate events. Many facilities around the country have now implemented required assessment of intraoperative fire risk during the timeout. Some strategies to reduce fire risks.

- Incorporating fire assessment in the surgical time-out.
- Surgical fire education.
- Placing lasers on STANDBY mode and replacing the electrocautery tip in the holster when they are not being actively used.
- Powering high-intensity light sources only when they are being used.
- Use of the lowest possible inspired oxygen concentration required for adequate oxygen saturation.
- Avoid tenting of surgical drapes to prevent oxygen accumulation.
- Use of water-soluble rather than oil-based substances to cover hair and other flammable parts of the body.
- Use of fire-retardant surgical drapes and draping patients only when all flammable preps are fully dried.
- Avoid electrocautery during tracheotomy while entering the trachea.
- Use of moistened gauze when working near the oropharynx.
- Report all fires to the Joint commission, ECRI, FDA and state agencies when appropriate

Operating room fires are considered Sentinel Events, and policy has been mostly directed towards prevention. What to do when a fire happens, however, is not as well emphasized. While these events are not common, they seem to occur when we are least prepared. Because of this, the Practice Advisory report for the Prevention and Management of Operating Room Fires by the American Society of Anesthesiologists

suggests as a matter of evidence, that running regular OR fire drills and simulation training can result in improved staff response to a fire [5]. The ASA also recommends displaying an easily visible protocol for the prevention and management of fires. Below is their suggested fire protocol (See attachment 2). Continuity of training involving the entire operating room team is also an important element when preparing for these situations [6].

Risk reduction strategies can improve safety, but will never eliminate the potential. When a fire does occur managing fear while ensuring safety and responsibility to the anesthetized patient are paramount. Staff participation in OR drills and training in the use of firefighting equipment, with emphasis on proper methods for escape and rescue, will improve response and potentially save lives. Drills can also minimize cost, response time, and emotional distress in the event of a real fire.

After this incident, our facility conducted a fire exercise including all residents, physicians and staff. Finally, everyone should become familiar with the legal responsibilities after a fire. Many states have regulations on fire reporting to the local fire departments. Other organizations, including JCAHO and the department of health, may also require hospitals to maintain adequate documentation of such incidents. When a fire occurs as a result of malfunctioning equipment, the FDA must also be notified in concordance with the Safety Information and Adverse Event Reporting Program. Failure to follow up with these requirements may be consider negligence, therefore it can impact the members of the healthcare team involved, as well as the entire organization.

Local Emergency Preparedness Project

In response to the recent operating room fire, the faculty and staff initiated an internal review process to identify weaknesses and areas for improvement in our emergency preparedness. While all of our equipment and protocols met or exceeded regulations set forth by the Occupational Safety and Health Administration (OSHA) and Joint Commission, the incident and subsequent review identified areas for improvement in 1) fire drill attendance and participation, 2) knowledge of pre-operative fire risk factors, 3) techniques for managing fire risk, 4) individual roles during an emergency, 5) evacuation routes and individual responsibilities, and 6) patient safety and professional accountability.

The first area for improvement involved our use of fire drills. While fire drills had been a part of our disaster preparedness plan for some time, attendance was limited to essential administrative personnel and available surgical staff. As such, participation was consistently poor. Following the review, this was changed to a mandatory event for all surgical staff, relevant administration, house staff, and attending surgeons. The drill was conducted during pre-scheduled protected educational block time and the OR schedule was adjusted in order to accommodate maximum participation.

The structure and contents of the fire drill were also heavily modified following the review. First, the opportunity to conduct group education sessions on various fire and safety topics was utilized. This included basic fire science and the fire tetrahedron (Figure 1), common and uncommon hazards in the operating room, fire risk stratification as part of the pre-operative “time-out” (Figure 2), and the ECRI recommendations for preventing operating room fires (Figure 3). In addition, whereas previous fire drills were largely didactic in nature and conducted at the central scheduling desk, the drills were modified to include “walking rounds” throughout the operative theatres to emphasize these points.

Throughout these walking rounds, knowledge of various critical

elements of the emergency response plan were assessed and emphasized. This included staff response to a fire alarm, evacuation procedures, alarm initiation, and finally a practical demonstration of staff knowledge. The course of these measures was tracked according to a standardized checklist (Figure 4).

In addition to utilizing the fire drill time for group education, modifications were made to develop team communication and problem-solving skills through practical application. This was accomplished through a series of mock cases involving a fire or other emergency. These simulations were performed in the operating room with the operating team fully gowned, various instruments, trays, and equipment about the room, and with a mock patient draped on the table. Every effort was made to make the simulation as true as possible. With the audience of surgical staff looking on, the team was confronted with multiple scenarios involving intra-operative emergencies including fire, power outage, and natural disaster. The team was required to access each scenario, take immediate steps to protect the patient and staff, contain the emergency when possible, and finally sound the alarm and activate the emergency response system. This simulation process alone represented a major milestone in our training regimen, and resulted in a marked and immediate improvement in our training process.

Overall, these changes represent a marked improvement in the comprehensiveness of our training and preparedness for the next major OR emergency. While no one expects an emergency or disaster situation to occur during routine operations, our experience has demonstrated that these situations can and do occur without warning. We believe that the training program implemented here will provide our OR personnel

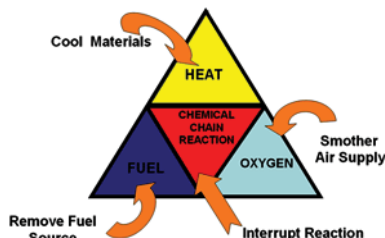


Figure 1: Fire tetrahedron representing the four elements that must be present to create fire as well as methods to interrupt the process (Enggyclopedia, n.d.).

Fire Risk Assessment Tool

- A. Is an alcohol-based prep agent or other volatile chemical being used preoperatively?
Yes
No
- B. Is the surgical procedure being performed above the xiphoid process?
Yes
No
- C. Is open oxygen or nitrous oxide being administered?
Yes
No
- D. Is an ESU, laser, or fiber-optic light cord being used?
Yes
No
- E. Are there other possible contributors (e.g. defibrillator, drills, saws, burrs)?
Yes
No

Figure 2: ECRI recommendations to prevent surgical fires. How they occur, how to prevent them, how to put them out., 2003).

At the start of surgery:

- Enriched O2 and N2O atmospheres can vastly increase flammability of drapes, plastics, and hair. Be aware of possible O2 enrichment under the drapes near the surgical site and in the fenestration, especially during head/neck surgery.
- Do not drape the patient until all flammable preps have fully dried.
- Fiberoptic light sources can start fires: Complete all cable connections before activating the source. Place the source in standby mode when disconnecting cables.
- Moisten sponges to make them ignition resistant in oropharyngeal and pulmonary surgery.

For surgery with open delivery of supplemental O2:

- Question the need for 100% O2 for open delivery during head/neck surgery.
- As a general policy, use air or ≤30% O2 for open delivery to the face.
- Arrange drapes to minimize O2 buildup underneath.
- Keep fenestration towel edges as far from the incision as possible.
- Use an incise drape to isolate head and neck incisions from O2 and alcohol vapors.
- Coat head hair and facial hair (e.g., eyebrows, beard, moustache) within the fenestration with water-soluble surgical lubricating jelly to make it nonflammable.
- For coagulation, use bipolar, not monopolar electrocautery.

During oropharyngeal surgery:

- Scavenge deep within the oropharynx with separate suction to catch leaking O2 and N2O.
- Soak gauze or sponges used with uncuffed tracheal tubes to minimize gas leakage into the oropharynx, and keep them wet.

When performing electrocautery, electrocautery, or laser surgery:

- Stop supplemental O2 (if O2 concentration is >30%) at least one minute before and during use of the unit, if possible.
- Activate the unit only when the active tip is in view (especially if looking through a microscope or endoscope).
- Deactivate the unit before the tip leaves the surgical site.
- Place electrocautery electrodes in a holster or another location off the patient when not in active use (i.e., when not needed within the next few moments).
- Place lasers in standby mode when not in active use.
- Do not place rubber catheter sleeves over electrocautery electrodes.

Figure 3: ECRI recommendations to prevent surgical fires (A clinician's guide to surgical fires. How they occur, how to prevent them, how to put them out., 2003).

Response to Fire Alarm- Staff Response

- Was the fire alarm pull station activated properly?
- Were patients requiring assistance for evacuation identified?
- Were patients accounted for and life support provided?
- Were person(s) in immediate danger evacuated?
- Did staff know the locations of fire extinguishers on the unit?
- Were corridors and egress routes clear?
- Were visitors cleared from corridors and directed to safe locations?
- Did ancillary personnel help secure equipment for transporting the patient as directed by the nursing supervisor?
- Did ancillary personnel follow instructions for evacuating the patient if needed and assist as directed?
- Were non-essential staff, visitors, and patients in adjacent areas directed to safe locations?
- Did staff close all the doors in the area?
- Did all automatic fire and smoke doors close or latch on the floor?
- Were OB doors secured by staff during the alarm?
- Did staff know emergency oxygen shut-off procedures for the unit?

Evacuation

- Was staff familiar with the building evacuation routes and procedures?
- Is staff aware of total number of patients on the units?
- Does staff know the location of emergency transportation equipment?

Alarm Initiation

- Was alarm visible and audible?
- Was the overhead page understandable and properly identifiable?
- Was the "Emergency Services Transmission" equipment signal received by the fire department or monitor company within 90 seconds?
- Was the "All Clear" properly called?

Demonstration of Staff Knowledge

- Did staff demonstrate knowledge of the "Code Red" function?
- Did staff know the emergency phone number "8"?
- Did staff know the location of the nearest fire alarm pull station?
- Did staff understand the meaning of R.A.C.E and P.A.S.S.?

Figure 4: Checklist created to track staff understanding and execution of the emergency response plan.

with the knowledge, skills, and practice to protect our patients, our staff, and our facility in the face of virtually any emergency. We will continue to conduct periodic drills, reassess staff response, conduct future training, and modify our training program to meet the changing hazards facing our department [7-12].

Conclusion

Operating room fires are an uncommon, but detrimental events to patients, OR staff, and to the entire institution. Understanding how these fires develop and adequately assessing the specific risks factors are essential elements in successfully preventing them. Regular fire drill exercises with the participation of the entire operating room team can improve the overall outcomes response once a fire occurs. After a fire, appropriate documentation and reporting must be followed.

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