A fire on or within a surgical patient is a continuing risk in modern surgery. Unfortunately, the sensitivity of surgical and anaesthesia staff to this hazard has waned over the past 25 years with cessation of the use of flammable anaesthetic agents. Prevention of surgical fires requires understanding the risks and effective communication between surgical, anaesthesia, and operating nursing staffs. Preventive measures exist but have yet to diffuse sufficiently across professional boundaries. Based on a review of relevant databases, decades of experience from field investigations, and a review of the medical literature, this paper discusses the incidence of surgical fires, the responsibility for prevention in the perioperative setting, and the procedures for surgical fire prevention and extinguishment.

INCIDENCE OF SURGICAL FIRES

There has been no formal repository for statistics on the incidence of surgical fires. Based on a review of the medical literature, anecdotal reports received over the past 25 years, field investigations of such incidents, and searching of the US Food and Drug Administration (FDA) medical device problem reporting databases, it is estimated that in the US up to 100 minor surgical fires occur annually, with approximately 10 of these being serious and one or two fatal.3 This incidence is small in comparison with the more than estimated 23 million outpatient surgical procedures performed each year in the US.3 4 These figures exclude the “miscellaneous diagnostic and therapeutic procedures” presented in the referenced data sources. Nonetheless, a surgical fire can be severely disfiguring or fatal and warrants attention by those concerned with providing safe health care.

One clear indication that surgical fires are continuing to occur can be seen by searching the FDA’s Manufacturer and User Device Experience Network (MAUDE) database and the Medical Device Reporting (MDR) database (http://www.fda.gov/cdrh/databases.html). For example, our search and review of reports in these databases for the 3.5 year span from January 1995 to June 1998 revealed 167 surgical fires. Of these, 56 (33%) were oropharyngeal, 47 (28%) were fires on the head or neck, 40 (24%) were fires ignited on the outside of the patient, and 24 (14%) were fires within the patient but not in the airway (for example, within a thoracotomy incision).

No similar searchable databases in other countries are readily available to the public. However, in the UK the incidence of surgical fires related to flammable prepping agents or to high intensity endoscopic light sources has been sufficient for its Medical Devices Agency (MDA) to issue related alerts.7 8

With the abundance of high energy surgical ignition sources, flammable surgical materials, and the potential for open oxygen sources, the hazard of surgical fire is clearly still with us. This conclusion is also supported by continuing reports of surgical fires in the medical literature.1–14 An expanded bibliography on surgical fires of more than 230 citations from 1969–2004 is available from the author via e-mail request.

RESPONSIBILITY FOR PREVENTION OF SURGICAL FIRES

Who is in the best position to prevent a fire during surgery? In large part, the answer...
within the surgical site and, conversely, the anaesthesia staff needs to be forewarned about each use of an ignition source. Communication on these issues during surgery is essential and must breach the boundaries of perceived professional territories. Education of clinical staff about the hazards of surgical fire is also essential, but is not currently addressed in most surgery or anaesthesia residency programs.

**Box 1 Extinguishing a surgical fire**

(1) **Fighting fires on the surgical patient**

Emergency procedure

- **Review before each surgical procedure.**

**In the event of a small fire on the patient, immediately**

- Pat out or smother the fire, or remove the burning material from the patient.

**In the event of a large fire on the patient, immediately**

- Stop the flow of breathing gases to the patient.

- Remove the burning material from the patient:
  - have another team member extinguish the burning material;
  - if needed, use a fire extinguisher to put out a fire involving the patient.

- Care for the patient:
  - resume patient ventilation;
  - control bleeding;
  - evacuate the patient if the room is dangerous from smoke or fire;
  - examine the patient for injuries and treat accordingly.

- If the fire is not quickly controlled, notify other operating room staff and the fire department that a fire has occurred:
  - isolate the room to contain smoke and fire.

Save involved materials and devices for later investigation.

(2) **Extinguishing airway fires**

Emergency procedure

- **Review before each surgical intubation.**

At the first sign of a tracheal tube fire, immediately and rapidly

- Disconnect the breathing circuit from the tracheal tube.

- Remove the tracheal tube:
  - have another team member extinguish it;
  - remove cuff protective devices and any segments of burned tube that may remain smouldering in the airway.

- Care for the patient:
  - re-establish the airway and resume ventilating with air until certain that nothing is left burning in the airway, then switch to 100% oxygen;
  - examine the airway to determine the extent of damage, and treat the patient accordingly.

Save involved materials and devices for later investigation.
Only You Can Prevent Surgical Fires
Surgical Team Communication is Essential

The applicability of these recommendations must be considered individually for each patient.

At the start of surgery:
- Enriched O₂ and N₂O atmospheres can vastly increase flammability of drapes, plastics, and hair. Be aware of possible enriched 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.
- Fiber optic 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 pulmonary surgery.

For surgery with open delivery of supplemental oxygen:
- 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 electrosurgery.

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

When performing electrosurgery, 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 electrosurgical 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 electrosurgical electrodes.

Reference: A clinician’s guide to surgical fires: How they occur, how to prevent them, how to put them out. Health Deve: 2003 Jan 32(1):5-24. Poster is available free on the Internet at www.mdscn.org. For more information, or to order large full-color, glossy posters of “Only You Can Prevent Surgical Fires,” contact ECRI.

ECRI
5200 Butler Pike, Plymouth Meeting, PA 19462-1998, USA
Tel: +1 (610) 825-6000 Fax: +1 (610) 834-1275 E-mail: info@ecri.org ©2004 ECRI. All rights reserved. Reprinted with permission.

Figure 2 ECR poster “Only you can prevent surgical fires”.

Unfortunately, a number of references in the literature have presented incorrect information regarding the flammability of common fuels in the surgical setting and the appropriate actions to take to extinguish a surgical fire. Such incorrect information can complicate constructive dialogue between medical professionals. For example, Podnos and Williams’s sought to address these topics for the surgical community but their article contained significant errors. With regard to extinguishment, they suggest that the best course of action for staff in a surgical fire is to get a fire extinguisher, pull fire alarms, and to evacuate the area through emergency exits. These recommendations are absolutely wrong. There is no time to get a fire extinguisher (or fire blanket) when your patient is on fire: physically removing the burning materials from the patient is the first priority (and is typically done instinctively by the staff). Moreover, the bulleted guidelines for fire prevention in the article are limited and confusing, granting that they probably did not originate with the authors. Specifically:

- “Use only appropriately protected endotracheal tubes when operating near the trachea.” This vague recommendation ignores differing ignition sources. Even laser resistant tubes will combust under certain circumstances, depending on oxygen concentration, laser wavelength, and tube materials. In addition, laser ignition resistant tubes are not resistant to electrosurgical ignition.
- “Use fire retardant surgical drapes.” There are no fire retardant surgical drapes given the potential presence of oxygen enriched atmospheres and the high energy delivery.
of lasers. No surgical drapes are treated with fire retardant, although some disposable drapes do have a degree of ignition resistance in air.

- The fire hazards of Betadine and iodine are misrepresented, suggesting that both are flammable. Only tinctures of Betadine or iodine are flammable. Standard Betadine scrub and paint are non-flammable aqueous solutions.

**PREVENTION PRACTICES**

Cogent, well researched recommendations for preventing surgical fires are available. The poster entitled “Only you can prevent surgical fires” (fig 2), provides a summary of specific preventive recommendations for medical and nursing staffs and may be freely reproduced. Clinicians should note that the applicability of the recommendations to any one patient must be considered individually for the needs of that patient. The poster and many other publications on this topic are available without restriction at ECRI’s free clinical website called Medical Device Safety Reports (www.mdsr.ecri.org, search term “fires”).

The Joint Commission for the Accreditation of Healthcare Organizations (JCAHO) in the US recently published an alert to healthcare facilities with recommendations about surgical fire prevention and education. For 2005 the JCAHO has also established a formal patient safety goal to “reduce the risk of surgical fires” in ambulatory care settings. The JCAHO fire prevention and education alert. They specify education for all surgical staff on “how to control heat sources and manage fuels” and require establishing guidelines to minimizing oxygen concentrations under drapes. These accreditation based initiatives may well succeed where the hundreds of articles on the causes and prevention of surgical fires published over the past 30 years in surgical, anaesthesia, and operating room nursing medical literature have failed.

**EXTINGUISHING A SURGICAL FIRE**

The action needed to extinguish a surgical fire depends on whether the fire is burning in the airway or on the outside of the patient. As mentioned above, most staff react instinctively when a fire breaks out to remove the burning material from the patient. In addition to this, other procedures shown in box 1 are warranted. These procedures differentiate between extinguishing fires burning on the patient and for fires in the airway.

Noteworthy citations that provide additional significant background and detail about the prevention of surgical fires are listed below under “Further reading”.

**CONCLUSIONS**

Surgical fires are a preventable hazard. As with any other low incidence but potentially serious or fatal medical misadventures such as wrong site surgery or retained instruments, solutions to prevent this hazard are known and published. However, preventive measures have yet to diffuse sufficiently across professional boundaries. The challenges to preventing fires relate to educating not one but three professions in the surgical setting—surgery, anaesthesia, and nursing—and in breaching barriers to intraoperative communication.

**ACKNOWLEDGEMENTS**

The surgical fire photograph, the graphics, and poster included in this article are reproduced with permission from ECRI, 2003. ECRI (www.ecri.org) is a non-profit making health services research agency with headquarters in Plymouth Meeting, Pennsylvania, USA and international offices in London, Dubai, and Kuala Lumpur. Its mission is to improve healthcare quality and reduce patient injuries and complications under drapes. These accreditation based initiatives are freely available at www.mdsr.ecri.org.

**REFERENCES**

4. ECRI. A clinician’s guide to surgical fires: how they occur, how to prevent them, how to put them out [guidance article]. Health Devices 2003;32:5–24.

**FURTHER READING**


7 ECRI. The patient is on fire! a surgical fires primer [guidance article]. Health Devices 1992;21:19–34.


Surgical fires: perioperative communication is essential to prevent this rare but devastating complication

M E Bruley

Qual Saf Health Care 2004 13: 467-471
doi: 10.1136/qshc.2003.005819

Updated information and services can be found at:
http://qualitysafety.bmj.com/content/13/6/467

These include:

References
This article cites 25 articles, 2 of which you can access for free at:
http://qualitysafety.bmj.com/content/13/6/467#BIBL

Email alerting service
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Notes

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/