Code Red
A Team Approach to Surgical Fires

Council on Surgical & Perioperative Safety
Alexander A. Hannenberg, M.D.
Roy Constantine, Ph.D., M.P.H.
T. Forcht Dagi, M.D., M.P.H., DMedSc

COUNCIL ON SURGICAL & PERIOPERATIVE SAFETY
Council on Surgical & Perioperative Safety
www.fda.gov/preventingsurgicalfires

Resources and Tools for Preventing Surgical Fires

Educational Videos:

- FDA Videos hosted by Medscape (Non-CME and CME)
  - Surgical Fires: How They Start and How to Prevent Them – FDA Expert Interview
    No registration required. No CME credits are available for this version.

- Prevention of Surgical Fires
  Continuing Medical Education (CME) credits are available to physicians for this video.
  Please see the Medscape.org site for CME details. (Registration required.)

- Prevention and Management of Operating Room Fires
  With the assistance of ECRI Institute, The Anesthesia Patient Safety Foundation (APSF) has produced this
  18-minute long video describes best practices to prevent the potentially devastating complication of a fire in
  the operating room. The intended audience is everyone who works in the OR during surgery. Watch the
  video online or request a complimentary DVD.

- FDA Patient Safety News: Preventing Fires in the Operating Room
  This 3 minute FDA video clip for health care professionals, summarizes the main points of APSF’s video.
  “Prevention and Management of Operating Room Fires.”

Preventing Fires in the Operating Room
Air
Oxygen

courtesy APSF
The Fire Triangle

- OXIDIZER
  - Oxygen, Nitrous Oxide, Room Air
- IGNITION SOURCE
  - ESUs, Lasers, Fiberoptic Light Sources
- FUEL
  - Alcohol-based Skin Preps, Surgical Drapes, Patient
Surgical Fire Epidemiology

- **Surgical Fires (~300-600/ yr)**
  - 44% Head/Neck/Upper Chest
  - 21% Airway
    - Tracheostomy, Tonsillectomy
    - Laser Resections

- **Frequency comparable to:**
  - Retained foreign objects
  - Wrong side/site surgery

- **Low Frequency – Highly Preventable**
Airway Fire

- Enriched oxygen delivery
- Combustible endotracheal tube
- Laser or cautery
# Pennsylvania Health Care Cost Containment Council Data

## Table 1. Rates of Fires per 100,000 Surgical Operations

<table>
<thead>
<tr>
<th>YEAR</th>
<th>NO. OF PATIENTS</th>
<th>NO. OF OPERATIONS</th>
<th>OPERATIONS PER PATIENT</th>
<th>NO. OF SURGICAL FIRES†</th>
<th>OPERATIONS PER FIRE</th>
<th>RATE OF SURGICAL FIRES PER 100,000 OPERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 2007 to June 2008</td>
<td>1,683,170</td>
<td>1,732,996</td>
<td>1.03</td>
<td>11</td>
<td>157,545</td>
<td>0.63</td>
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<tr>
<td>July 2008 to June 2009</td>
<td>1,727,387</td>
<td>1,775,920</td>
<td>1.03</td>
<td>7</td>
<td>253,703</td>
<td>0.39</td>
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<tr>
<td>July 2009 to June 2010</td>
<td>1,757,928</td>
<td>1,807,384</td>
<td>1.03</td>
<td>12</td>
<td>150,615</td>
<td>0.66</td>
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<tr>
<td>July 2010 to June 2011</td>
<td>1,805,835</td>
<td>1,855,832</td>
<td>1.03</td>
<td>6</td>
<td>309,305</td>
<td>0.32</td>
</tr>
<tr>
<td>Total</td>
<td>6,974,320</td>
<td>7,172,132</td>
<td>1.03</td>
<td>36</td>
<td>199,226</td>
<td>0.50</td>
</tr>
</tbody>
</table>

* Data obtained from the Pennsylvania Health Care Cost Containment Council.
† Surgical fires reported to the Pennsylvania Patient Safety Authority.
OXIDIZERS

Alexander A. Hannenberg, M.D.
Immediate Past Chair, CSPS
Past President
American Society of Anesthesiologists
Anesthetic Gases

- Oxygen
- Nitrous Oxide
- Medical Air
ASA Closed Claims Study 1985-2009
Key Findings

- 103 Closed Claims – OR Fires
- 90% Ignition = Electrocautery
- 85% Head/Neck/Upper Chest
- 84% Open Oxygen source
- 20% Permanent Disability/Death

Mehta SP et al. Anesthesiology 118:1133, 2013
Recommendations

“The risk of OR fires can presumably be reduced by following the recommendations of the ASA Practice Advisory, the Anesthesia Patient Safety Foundation and the recent initiative surgical fire prevention program by the Food and Drug Administration to promote safer practices and share fire prevention resources. **The approach involves all of the members of the surgical team – surgeons, anesthesia providers, nursing and technical staff.** Team communication of fire risk and prevention is important during the presurgical checklist, as well as intraoperatively....”

Mehta SP et al Anesthesiology 118:1133, 2013
Fire Prevention Algorithm*

Is patient at risk for surgical fire? (Procedures involving the head, neck and upper chest/above T5 and use of an ignition source in proximity to an oxidizer.)

- **YES**
  - Proceed but reassess for changes in fire risk frequently.
  - Nurses and surgeons avoid pooling of alcohol based skin preparations and allow adequate drying time. Communication between surgeon and anesthesia professional prior to initial use of electrocautery.

- **NO**
  - Does patient require oxygen supplementation?
    - **YES**
      - Is >30% oxygen concentration required to maintain oxygen saturation?
        - **YES**
          - Secure airway with endotracheal tube or supraglottic device.†
        - **NO**
          - Use delivery device such as blender or common gas outlet to maintain oxygen below 30%.
    - **NO**
      - Room air sedation.

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† Although securing the airway is preferred, for cases where using a device is undesirable or not feasible, oxygen accumulation may be minimized by air insufflation over the face and open draping to provide wide exposure of the surgical site to the atmosphere.

*The following organizations have indicated their support for APSF efforts to increase awareness of the potential for surgical fires in adults and pediatric patients: American Society of Anesthesiologists, American Association of Nurse Anesthetists, Association of PeriAnesthesia Nurses, Anesthesia Patient Safety Foundation, Association of periOperative Registered Nurses, TCOH Institute, Food and Drug Administration Safe Use Initiative, National Patient Safety Foundation, The Joint Commission.
Surgical Safety Checklist

Before induction of anaesthesia
(with at least nurse and anaesthetist)

- Has the patient confirmed his/her identity, site, procedure, and consent?
  - Yes
  - No

- Is the site marked?
  - Yes
  - No applicable

- Is the anaesthesia machine and medication check complete?
  - Yes
  - Not applicable

- Is the pulse oximeter on the patient and functioning?
  - Yes

- Does the patient have a:
  - Known allergy?
    - No
    - Yes
  - Difficult airway or aspiration risk?
    - No
    - Yes, and equipment/assistance available
  - Risk of >500ml blood loss (7ml/kg in children)?
    - No
    - Yes, and two IVs/central access and fluids planned

Before skin incision
(with nurse, anaesthetist and surgeon)

- Confirm all team members have introduced themselves by name and role.
- Confirm the patient’s name, procedure, and where the incision will be made.

- Has antibiotic prophylaxis been given within the last 60 minutes?
  - Yes
  - Not applicable

- Anticipated Critical Events
  - To Surgeon:
    - What are the critical or non-routine steps?
    - How long will the case take?
    - What is the anticipated blood loss?
  - To Anaesthetist:
    - Are there any patient-specific concerns?
  - To Nursing Team:
    - Has sterility (including indicator results) been confirmed?
    - Are there equipment issues or any concerns?

Before patient leaves operating room
(with nurse, anaesthetist and surgeon)

- Nurse Verbally Confirms:
  - The name of the procedure
  - Completion of instrument, sponge and needle counts
  - Specimen labelling (read specimen labels aloud, including patient name)
  - Whether there are any equipment problems to be addressed

- To Surgeon, Anaesthetist and Nurse:
  - What are the key concerns for recovery and management of this patient?

This checklist is not intended to be comprehensive. Additions and modifications to fit local practice are encouraged.
Christiana Fire Risk Assessment Score

- Surgical site above xiphoid = 1
- Open source oxygen delivery = 1
- Ignition source in use = 1

Score = 0 – 2
Normal precautions

Score = 3
High Risk Protocol
Oxygen Delivery

Open Oxygen Delivery Systems
*Mask, Nasal Cannula*

Closed Oxygen Delivery Systems
*Laryngeal Mask, Endotracheal Tube*
Supplemental Oxygen: Think Twice
Controlling Oxygen Delivery

Alternative fresh gas outlet

Oxygen blender
Roy Constantine PA-C, MPH, Ph.D.
Past President American Association of Surgical Physician Assistants

Assistant Director of Mid-Level Practitioners
St. Francis Hospital, Roslyn - New York
DEFINITIONS

A **FUEL** is defined as anything that will burn. *(AORN)*

**OR FIRES** are defined as fires that occur on or near patients who are under anesthesia care, including surgical fires, airway fires and fires within the airway circuit. *(ASA)*

**AIRWAY FIRES** are a specific type of surgical fire that occurs in a patient’s airway. Airway fires may or may not include fire in the breathing circuit *(ASA)*
INTRINSIC
Emphasis on Communication and Teamwork

THE PATIENT

PERSONNEL

Fat is highly flammable

Muscle

Lanugo – fine hair that covers most bodily surfaces (found predominately on the face. Once burning – fire propagates at 2 – 10 feet per second.

Prevention – Covering hairs with water soluble lubricant

Emergency Care Research Institute: The patient is on fire: A surgical fires primer. Health Devices, 21:19, 1992

Skin (with prep solutions)

Human Flatus - Gastrointestinal Gases

-Hydrogen and methane – extremely flammable gases – produced in GI tract –
Approx. 200mls/day

-Adding 5% oxygen - explosions can occur with hydrogen (4-72%) and methane (5-15%)


A FUEL SOURCE

2% w/v chlorhexidine gluconate (CHG)
and 70% v/v isopropyl alcohol (IPA)
Patient Preoperative Skin Preparation
1.5ml FREPP® APPLICATOR

WARNING. FLAMMABLE.
KEEP AWAY FROM FIRE OR FLAME.
do not drape or use ignition source (e.g., cautery, laser)
ungtill solution is completely dry (minimum of 3 minutes
on hairless skin; up to 1 hour in hair).
APPLICATOR STERILE UNLESS SEAL IS BROKEN

Single Use
Latex Free
**EXTRINSIC**
Emphasis on Communication and Teamwork

*Prep Solutions*

Antiseptic skin agents, especially with alcohol bases are very flammable.

Prep solutions with alcohol must be allowed to dry before use.

Betadinesolution (10% povidine-iodine) is also inflammable - not recommended for the cleaning of skin in the presence of an ignition source. Explosions have occurred in the presence of high oxygen or nitrous oxygen concentrations. *(Prep + 2 elements of the fire triangle)*

LESS OBVIOUS SUBSTANCES that can ignite and be catastrophic

- Tinctures
- Collodion - a syrpy solution (a.k.a) – nitrocellulose, cellulose nitrate, flash paper and gun cotton in either and alcohol
- Dermatome Glue
- Bone Cement

- Other – DRAPES, GAUZES
- Gowns
- Tape
- Head Coverings
- Shoe Coverings
- Blankets
- Gloves
- Tubings (Extrinsic)
A FUEL SOURCE
A FUEL SOURCE
A FUEL SOURCE
Drapes (Most commonly ignite)

There are no fire-retardant drapes. Few drapes have some degree of resistance to ignition in ambient air, but they will burn in an oxygen enriched environments (AORN)
Emphasis on Communication and Teamwork

- Oxygen enriched environments can exist beneath drapes
- During facial and ophthalmic procedure special awareness for potential disaster exists

Barnes A., Frantz, R. (2000). Do oxygen-enriched atmospheres exist beneath surgical drapes and contribute to fire hazard potential in the operating room. AANA Journal. 68(2)
Oxygen Index (OI)
Emphasis on Communication and Teamwork

“An effective method for minimizing operating room fires is to use materials that are least flammable in air and in oxygen-enriched atmosphere”

OI = minimum amount of oxygen required to support a candle-like flame on a test specimen:

“Ignited materials with OIs less than or equal to 21% (woven cotton and non-woven cellulose) a flame can propagate away from the ignition points and encompass the entire drape.”

“Utilizing a drape with an OI greater than 21% (such as polypropylene) would prevent such scenario.

Serrao, GW, Micou, MK, Sidebotham, GW and Wolf, GL. The Oxygen Index of Surgical Drape Materials. The Cooper Union for the Advancement of Science and Art
OXYGEN INDEX (OI)

Woven cotton towels = 17.8
Non-woven Cellulose Draping = 18.5
Polypropylene draping = 22.8

*Both cloth and paper drapes (the most implicated fuel for fires – ignitable by devices)
Strategies to Prevent Drape Fires
Emphasis on Communication and Teamwork

- “Drapes should not be allowed to cover the face”

- “If drapes over the face are necessary for sterile field purposes….tenting the drapes to allow the heavier oxygen molecules to sink to the floor instead of being trapped just below the drapes and near the operative site” is suggested

- Barnes, A. & Frantz, R. 2000. Do oxygen-enriched atmospheres exist beneath surgical drapes and contribute to fire hazard potential in the operating room. AANA Journal. 68 (2)
A FUEL SOURCE
Endotracheal tubes

- Highly Flammable PVC or Silicone
- They can also be made out of plastic, red rubber and metal. Only metal is non-flammable.
- Danger due to close proximity to the tube with high concentrations of oxygen.


Cuffed polyvinyl chloride endotracheal tubes may decrease the risk of fire. (Low flammibility index; prevent oxygen leakage into the surgical area) (Int J pediatrOtorhinolaryngol. 2008; 72 (7):1013-1021)
Gauzes / Dressings

An intervention can be the use of moist towels when using a laser device. Water soaked items require higher temperatures to ignite compared to when they are dry.

Use saline-moistened instead of dry sponges in the surgical field (Health Devices, 2009; 38 (10): 319)
Interventions
Emphasis on Communication and Teamwork

- Moist sponges
- Water based ointments on facial hair and close to the surgical site
- Prevent pooling of skin prep solutions
- Remove prepping drapes or towels that catch the pooled solutions
- Allow skin preps to dry and fumes to dissipate before draping
- Conduct a skin prep “time out” (AORN)

- Emphasis on Draping Techniques
- Emphasis on Tubes
A combination of fuel sources decreases the amount of energy (ignition source) required to start a fire. Example, an alcohol soaked towel will ignite faster than a dry towel will. (AORN)
Sources of Ignition in the Operating Room

T Forcht Dagi MD, DMedSc, MPH, FAANS, FACS, FCCM, FRCSEd
Harvard Medical School and Queen’s University Belfast
Potential sources of ignition

- Power cords
- Electrocautery
- Lasers
- Light sources
- Drills, and burrs
- Defective grounds and short circuits
- Static electricity
- Hyperthermia units
- Blood and fluid warmers
- Pumps
- Microscopes
- Monitors
- Computers
Electrocautery

- All types of electrocautery have been implicated
  - Monopolar
  - Bipolar
  - Battery-operated
  - Power sources
  - Tips

- Temperature can reach several hundred degrees
  - More than sufficient to ignite paper or cloth drapes or other fuel sources
Lasers

- Intense, focused light
- Temperature sufficient to melt or ignite
- All frequencies, colors and types
- Direct ignition
  - From the beam onto paddies, sponges, drapes, throat packs, swabs, clothing, hair, tubes
- Indirect ignition
  - By reflection
    - Shiny instruments
    - Puddles of water
Light sources

- Overhead
- Headlights
- Endoscopes
- Fiberoptic

**Mechanisms include**
- Defective wiring
- Proximal electrical or thermal failure at light source
- Distal electrical or thermal at light bulb or tip of fiberoptic cable
Surgical instruments

- Heat from drills and burrs spinning with insufficient irrigation
- Sparking electrical instruments
- Defective grounds and short circuits
Static Electricity

- Buildup and discharge
- Ineffective grounding
Other sources of ignition

- Hyperthermia units
- Blood and fluid warmers
- Pumps and lavage systems
- Microscopes
- Defibrillators
- Embers from charred tissue
- Monitors
- Computers
- Power cords
Preventing ignition

- Awareness
- Communication, teamwork and training in the operating room
- Include technicians, residents, assistants, students, anesthesiologists, radiographers, orderlies, students, perfusionists, engineers, environmental services
- Effective maintenance of equipment and apparatus
- Adequate grounding and anti-static precautions
- Watch for concentrated light sources of any origin
Specific measures

- **Electrocautery**
  - Keep tip in the holster when not in use – preferably off patient
  - Avoid automated electrocautery
  - Avoid placing rubber catheter sleeves over electrosurgical electrodes
  - Activate only with tip in view, especially during microsurgery
  - Deactivate unit before the tip leaves the surgical site

- **Lasers**
  - Standby mode when not in active use
  - Use non-reflecting surgical instruments
  - Monitor any reflecting surface, such as pools of liquids
  - Watch for transparent drapes in the path of the laser

- **Fiberoptics**
  - Complete all fiberoptic cable connections before activating light source.
  - Power up high-intensity light sources only when in use
  - Place light sources on standby, or turn the unit off when disconnecting cables.
  - Never leave an illuminated light cord on patient drapes

- **Adequate cooling when drilling or shaping**
Summary: Fire Prevention

♦ Technical
  ▪ Well maintained equipment
  ▪ Safe practice
  ▪ Vigilance
    ➢ Systematic risk (random, non-specific or aggregate)
    ➢ Non-systematic risk (non-random, specific or inherent)

♦ Human
  ▪ Training
  ▪ Communication
  ▪ Collaboration
  ▪ Commitment
Operating room fires are preventable

THIS MATTERS

Thank you