Fire in the OR
Developing a Fire Safety Program
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Case Presentation

- 41 y.o. male with PMHx of BCC of nose presented for nasal mass excision and nasolabial flap procedure.
- Nasal cannula and a face tent was used during the procedure to deliver oxygen.
- Electocautery was used which caused the face tent to catch fire.
- The episode was approximately 3 seconds.
Patient sustained 1\textsuperscript{st} degree burn to the face, 2\textsuperscript{nd} degree burn to lips and tongue.

- ENT and OPHT were consulted.
- Patient was intubated.
- Flap procedure was completed.
- Extubated and observed in RR for airway management.
- POD\#3: D/C home.
Frequency

- Rare events, but are devastating in terms of structural damage to the equipment in O.R. theatres and to human lives.
- Frequency has decreased steadily over the past 40 years mainly because of greater awareness of contributory factors.
- Approximately 100 OR fires/year in the US.
### Table II.
Complications Related to Electrosurgery.

<table>
<thead>
<tr>
<th>Complication</th>
<th>Complications in Previous Year</th>
<th>Complications in Surgeon’s Career Prior to Past Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unanticipated direct burn</td>
<td>219</td>
<td>597</td>
</tr>
<tr>
<td>Capacitive coupling</td>
<td>48</td>
<td>206</td>
</tr>
<tr>
<td>Grounding pad burn</td>
<td>13</td>
<td>32</td>
</tr>
<tr>
<td>Fire</td>
<td>11</td>
<td>29</td>
</tr>
<tr>
<td>Electromagnetic interference</td>
<td>32</td>
<td>62</td>
</tr>
<tr>
<td>Hair loss at incision</td>
<td>1</td>
<td>NR</td>
</tr>
<tr>
<td>Surgeon or assistant burn</td>
<td>NR</td>
<td>1</td>
</tr>
<tr>
<td>Alternate site grounding burn</td>
<td>NR</td>
<td>6</td>
</tr>
</tbody>
</table>

Table II includes number and categories of electrosurgical complications occurring during the past year or during the surgeons’ career prior to the past year.

**NR** = none specifically reported.

"I was just going in for a simple lymph node biopsy,"
Facial Burn in O.R.
Ingredients for Fire
Fuels

Ointments & solutions:
- Alcohol (also in a catgut suture packet)
- Chlorhexidine
- Benzoin
- Mastisol
- Petrolatum or petrolatum-based ointment (use K-Y jelly)
- Acetone
- Ether
- Aerosols
- Wax

Drapes and dressings:
- Cloth or paper drapes/towels
- Cloth or paper gowns
- Sponges, laps, ray-techs
Fuels (cont.)

Equipment in field:
- A. Plastic: Steri-drape, Tegaderm, Nasogastric tubes, Endotracheal tubes, Oxygen line,
- B. Latex/rubber Gloves
- C. Suture
- D. Mesh

Patient:
- A. Hair
- B. Clothing/gown
- C. Gastrointestinal gasses
Oxidizer

- The source of oxygen is often atmospheric air, Nasal Cannula, etc.
- Nitrous oxide can also generate oxygen for combustion.
HEAT

- Electrosurgical unit (ESU)
- Laparoscopic ESU
- Fiberoptic light source
- Laser
- Burrs and drills
- Defibrillator
The first electrosurgical generator was produced through the collaboration of a physicist and a surgeon. At Harvard in 1926, a physicist named William T. Bovie (1882–1958) developed an electrosurgical device to aid in the removal of tumors. Harvey Cushing (1869–1939) attended a staff meeting where the progress of this research device was discussed and Cushing became interested. Cushing’s operative note recorded the event: “The operation was a perfect circus—many ringed. I had persuaded Dr. Bovie to bring his electrosurgery unit over here to let me see what I could do with his cutting loop.”
Mechanism: Electric Current

- Alternating current flows from the electrosurgical unit and a high current density occurs at the tip of the active electrode.
- The current density is lower at the pad and the current is returned to the ESU to complete the circuit.
Mechanism: Electric Current
RadioFrequencyAblation (RFA)

Mechanism: Heat

The high current density in tissue within a few millimeters of the needle electrode causes a rapid local temperature rise, to a range of 50–90°C, within seconds to minutes, resulting in thermal injury and irreversible tissue destruction.
Kimberly A. Kressin, ASA, June 2004
Volume 68 Number 6
Burn Injury in the Operating Room
Location of Burn

- Trunk, Including Axilla: 28%
- Arms/Hand/Fingers: 18%
- Buttocks/Thighs Legs/Feet: 21%
- Face: 21%
- Airway: 3%
- Multiple Areas/Other/Unknown: 8%
Trends in Burn Claims Over Time

- I.V. Bag or Bottle
- Warming Device
- Cautery Fire
- Cautery Burn
- Other

% of burn claims in time period

1994 or earlier
1995 and later

*p<0.05
Fires Involving Endotracheal Tubes

- The technique of using the electrocautery to incise the trachea for tracheostomy can cause a catastrophic fire if the cautery contacts the endotracheal tube or its balloon.

Pyloric stenosis and obstruction allows for more prolonged degradation of stomach contents by gastric acid and proliferating bacteria to occur, resulting in increased amounts of flammable gases.

It is advisable not to use cautery on obstructed gastrointestinal tract.

Many incidents have been reported where dilated stomach was opened with diathermy and a loud explosion occurred.

- Carrol KJ, BMJ 1964
Laparoscopic Surgery

- In the past when oxygen or NO were used for peritoneal insufflation during laparoscopies there were incidents of fire and explosions.

- CO$_2$ used today for insufflation:
  - high blood solubility and thus causes less danger of gas embolus
  - Inhibitory effect on flammability.

Laparoscopic Surgery (cont.)

- The heat at the end of the endoscope’s halogen light is clearly sufficient to ignite flammable materials in close proximity to it.
  - Taylor IR (Hazards of laparoscopic surgery)
  - Greilich PE, Greilich NB, Froelich EG. Intraabdominal fire during laparoscopic cholecystectomy.
    Anesthesiology. 1995 Oct;83(4):871-4
intraabdominal fire secondary to insufflating the incorrect concentration of carbon dioxide gas during a laparoscopic cholecystectomy.
Make Sure You Use the Right Tank!!

100% CO₂

14% CO₂
86% O₂

Green
Fires and Bowel Surgery

- **R hemicolecctomy**

- **Explosions occurring during a feeding jejunostomy**

- **Opening a caecostomy with diathermy (fatal case)**

- **Colotomy for removal of colonic polyp**

- **Colon interposition for oesophageal stricture**
In All These Cases Diathermy Was Used to Open the Bowels
Fuel in the form of free gas has been reported to come from the perforated stomach, after cardiopulmonary resuscitation. Oxygen used during cardiopulmonary resuscitation had entered the peritoneal cavity through perforated stomach. The source of ignition was diathermy. (Fatal)


- corresponds to the position of the axillary roll.
- The roll comprised a liter bag of crystalloid wrapped placed under the dependent axilla.
- The bag of fluid was obtained from a warming cabinet that maintains a fairly constant temperature of 37 °C. Furthermore, the pressure exerted by the patient's weight on the dependent.
Thermal injury during temporomandibular joint arthroscopy: a case report:

26-year-old woman developed thermal injury by electrocautery during TMJ arthroscopy. The electrocautery probe was occasionally passed through anterior and/or posterior cannulas.

The skin surrounding the 2 puncture sites showed erosion with loss of the epithelial layer at the end of the operation, indicating a burn.

Thermal burn scars 8 months after the initial surgery.

The larger wound and the smaller wound (*arrows*) coincide with the arthroscopic puncture points.
Fire Prevention Measures
Oxygen supplementation during head and neck surgery under local anesthesia, with or without sedation, carries the risk of fire.

**Tricks:**
- cut off the prongs and insert one or both ends of the tubing deeper into the nose or mouth.
- generally safe to place the prongs in the patient's mouth when operating on the upper face.
- The tubing should be taped.
- during facial surgery under local anesthesia, instruct the anesthetist to turn off the oxygen, then wait at least 60 seconds before using EC. (tedious but safe),
- O2 at the lowest setting (2 to 3 l/min is enough)
Heat

- When not in use, the fiberoptic light source should be turned off. The light, if left on dry drapes over time, can cause ignition, especially near areas of high oxygen concentration.
- Cautery should be set to the lowest power setting that still allows it to function efficiently.
- A clean cautery tip must be maintained to avoid carbon accumulation, which will also tend to cause heat buildup.
Fuels

- Sponges, laps, ray-techs, and nasal/throat packs must be moistened thoroughly with water or saline to inhibit combustion, *especially* when oxygen supplementation is used.
- For facial operations, facial hair should be coated with K-Y jelly.
- Excess solution should be wiped away with water or saline before using the EC.
Fuels, ctd.

- Once a small opening is made in the peritoneum sufficient to let out the explosive flammable gases, the rest of the incision can be extended with the diathermy.
Prep Solutions

- Alcohol based cleansing agents have resulted in severe burns to skin.
- Alcohol should not be used as a prep solution.
- Chlorhexidine contains alcohol, but in aqueous solution that is less flammable.
- Excess prep solution must be wiped away before draping to prevent flammable vapors from collecting under drapes.
- Betadine (water-based prep), contains no alcohol and are considered nonflammable.
Tinctures & Ointments

- Benzoin, Mastisol, etc. all contain alcohol.
- These dangerously flammable solutions should be used with caution in the OR.
- Be aware that catgut suture is stored in a 10% alcohol solution in the pack.
- Petroleum jelly (Vaseline) and petroleum-based ointments can ignite in the presence of oxygen.
- A water-soluble lubricant (K-Y jelly) should be used instead of petrolatum on the field because it is not flammable.
Laparoscopic Surgery

- CO₂ usage for insufflation.
- The light cable end registers a temperature of 101 degrees C with the potential for causing skin burns.
- It is recommended that the light source should be switched on only when used. The light cable end must not rest on the drapes once the light source has been switched on, as thermal burns will occur within seconds.
Long-Term Fire Prevention

1-Personnel Education:
- A. Policy manual
- B. Orientation program
- C. Annual in-service with test
- D. Principles of EC
- E. Fire safety certification

2-Develop and update safety program standards
Conclusions

- One should avoid the use of diathermy to open the peritoneum in emergency laparotomy, particularly where there is free gas in the peritoneal cavity or bowel perforation is suspected.
- One may use diathermy, at the minimum possible current necessary, and open the peritoneum with a knife or scissors.
- A fire safety education program, heightens the OR staff's awareness of fire safety issues, leading to a decrease in the incidence and severity of OR fires.
- The end result is a safer environment for patients and staff in the OR.