Your Patient is on Fire!
Preventing and Managing O.R. Fires

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Objectives

- Understand the elements of the "Fire Triangle"
- Recognize the contributions of Anesthesia, Surgeons, and O.R. Personnel to O.R. Fires
- Describe techniques to reduce the likelihood of O.R. Fires

Fire Triangle

- Oxidizing Agent: Usually supplied by Anesthesia
- Fuel: Usually supplied by O.R. Nurses
- Ignition Source: Usually supplied by Surgeon
Fire Triangle

Oxidizing Agent

O₂, N₂O, and Air

Ignition Source

Electrosurgery, electrocautery, or laser units; High-speed drills, defibrillators, and static electricity

Fuel

Flammable prep solutions, solvents, sheets, drapes, paper goods, alcohol suture solutions

Oxygen Supports Combustion

• Oxygen is generally under the control of the anesthetists
• Nitrous oxide will also support combustion
• Concentrations above 21% O₂ will increase the possibility of fire

Sources of Ignition

• Surgeons generally have control of ignition sources
  — Electrocautery units
  — Lasers
  — Fiberoptic light sources and cables
  — High-speed drills
  — Static electricity

1540 A.D.

A woodcut by Johannes Wechtlin, showing a selection of cauterizing irons and a patient having his thigh cauterized after injury
**Fuel Sources**

O.R. Nurses usually Control this Element

- All materials capable of igniting:
  - Drapes, sheets
  - Paper goods
  - Prep solutions
  - Solvents
  - Alcohol, colloidion
  - Petroleum-based ointments

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**Woman Dies in Operating Room Fire at UCLA Medical Center**

LOS ANGELES (AP) Sheets covering a patient caught fire during surgery yesterday, filling an operating room with smoke so thick that staff members couldn’t extinguish the flames. The patient died. It was not known if Ms. Hernandez died because of the fire and smoke, her injuries or a combination of the two factors. Eight to 10 medical staff members, including doctors and nurses, were performing the operation when flames engulfed the surgical cloth over the patient. There was a serious attempt by the staff to extinguish the fire.

But the smoke became so bad that the operating room staff members had to leave the room and university police arriving at the scene could not get inside the room. It was the second time in 1-1/2 years a patient has died in an operating room blaze in a Southern California hospital. A 15-year old boy was fatally burned at Cedars-Sinai Medical Center when a spark from an electric cauterizer, used to stop bleeding, started a fire that was strengthened by the high concentration of oxygen in the room. UCLA Medical Center officials declined to say if doctors had been using a cauterizer yesterday.

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**Physician’s Wife Suffers 2nd and 3rd Degree Burns During Minor Surgery**

Case Report

- “
- Local / MAC technique
- Burns covered face, neck, and chest
- Will need several reconstructive surgeries with cost of $50,000.00
- Cautery and oxygen sparked a fire on cleaning solution
Cautery ignited surgical drapes in oxygen-rich environment
During removal of several benign tumors from her head and back

Melanie Allen remembers being jolted awake and screaming. I'm on fire, I'm on fire!

"My lips were cooked, and my sinuses burnt up."

Four Fires in Ohio
That I am aware of in past several months

1. Plastic surgery on face with local / MAC (mask O₂)
2. Severe facial burn with local / MAC (surgery near clavicle)
3. Chest Wall burn from prep solution ignition under general anesthesia
4. Neck and Facial Burn from prep solution ignition with General ETT Anesthesia

What is Oxygen?

- an element that is found free as a colorless tasteless odorless gas in the atmosphere of which it forms about 21 percent
- is active in physiological processes
- is involved especially in combustion processes
What is Oxygen?

- Oxygen contains 8 protons in its nucleus with 8 electrons revolving around it.
- Often shown in chemical notation as the letter O surrounded by eight dots representing 4 sets of paired electrons.

Oxygen Cannula or Mask?
That is the Question

<table>
<thead>
<tr>
<th>Nasal Cannula</th>
<th>Face Mask</th>
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</thead>
<tbody>
<tr>
<td>Run at 1-3 L/min</td>
<td>Run at 4-8+ L/min</td>
</tr>
<tr>
<td>Generally smaller volume of O₂</td>
<td>Delivers a higher volume of O₂</td>
</tr>
<tr>
<td>Less FiO₂ level to patient</td>
<td>Greater FiO₂ to patient</td>
</tr>
<tr>
<td>Less concentration of O₂ to ambient air</td>
<td>More concentration of O₂ to ambient air</td>
</tr>
<tr>
<td>May not be adequate for all patients</td>
<td></td>
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</tbody>
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Management of Surgical Drapes

- Position drapes in a vertical manner in front of the patient’s face so that oxygen cannot be “trapped” around the head and neck.
- “Vent” the area if the surgical site is above the xyphoid process.
Flammable Prep Solutions

- Flammable vapors
- Must dry 2-3 minutes
- Do not allow to pool
- Do not allow contact with hair
- Removed soaked materials

Skin Prep Solutions

- Consider avoiding the use of flammable solutions to prep the skin
- If used, let it dry adequately and follow the manufacturer’s recommendations closely
Recommendations for Defibrillation

- Remove all O₂ sources from near the patient
- Reduce risk of electrical arcing by:
  - Apply paddles firmly (25lbs per paddle)
  - Apply ECG electrodes as far from paddles as possible
  - Use chest pads larger than the paddles

Management of Surgical Drapes (Cont.)

- Arrange the drapes for ready access to the patient’s face to:
  - Allow for observation
  - Maximal exchange of ambient room air
  - Communications with the patient
  - Ready access for airway manipulations
Regionals and MACs are NOT General Anesthetics (Despite what the Surgeon May Think)

- We have spoiled the surgeons
- They think you do not have to have sufficient local anesthesia if a MAC is the stated technique
- Therefore, we "oversedate" with propofol, fentanyl, etc.
- Therefore, more oxygen is given to maintain the oxygen saturation (along with a substantial chin-lift)

$O_2$ is Heavier than Air

Hey Genius!
So What if Oxygen is heavier than air!
• It will gravitate
• It will concentrate
• It will activate potential combustion

**O2 is Heavier than Air**

- Patient may be getting 40% FiO₂, but 100% O₂ is being administered
- Will invariably increase ambient O₂ concentration
- Do not allow O₂ to be trapped
- Place drapes to optimize good air exchange
- Consider using a "vent" suction evacuator
- Use O₂ at lowest possible flow rate

**Definition of Oxygen-Enriched Environment**

An atmospheric oxygen concentration of greater than 23.5%*

* Defined by the National Fire Protection Association
“Vent” Evacuation Device
(To reduce O₂ Concentration)

- Made from empty saline bottle
- Suction tubing connected to suction
- Place near area where O₂ is likely to concentrate to pull excess O₂ from the area

Suction tubing to vacuum
Open-end N/S Bottle

Safety in the Use of Compressed Air Versus Oxygen for the Ophthalmic Patient

Oxygen is used routinely during surgery to prevent hypoxia that may result from inhaled anesthetics. However, in some cases, exposure to high concentrations of oxygen can lead to respiratory depression and hypoxia. Oxygen supplementation and coughing involve no risk, but airway suction is required if hypoxia occurs. Oxygen administration during the use of cautery on a patient with emphysema or chronic obstructive pulmonary disease may produce an operating room fire of a ventilating surface. In virtually all cases, the adherence to surgical oxygen delivery reduces the risk of such fires.

Improving Safety in the Patient Undergoing Ophthalmic Surgery

- Administer nasal O₂ during initial sedation & eye block
- Replace O₂ with medical grade air during the use of cautery
- Communicate with surgeon to coordinate O₂ use only when cautery is not being used (if patient is able to tolerate, as indicated by SaO₂ values
- Use "venting"
- Use "incise" type draping
All Electrosurgical Units (and Lasers) can Ignite Flammable Materials
(Battery powered or 120 volts)

Making Connections of Surgical Equipment

- Do not make connections while equipment is "on"
- Always keep cautery in holster when not in use
- The hot tip of a cautery unit can ignite the drapes
- Remove contaminated cautery tip
- Activate heat sources only when the tip is in view
- Deactivate before the tip leaves the surgical site

Laparoscopic Procedures are Performed with CO₂ (for a good reason)

- Is readily absorbed and exhaled
- Does not support combustion
- Prevents explosions
Fires Have Occurred during Tonsillectomy

In mid-April, an 8-year-old boy’s mouth, throat, and lungs were burned when his breathing tube ignited during a tonsillectomy at the San Jose Medical Center in Northern California.

Management of T&A

- O₂ and N₂O are both used
- Non-cuffed ETTs are used in younger patients
- Sponges, gauze, pledgets and strings need to be kept moistened when in use
- Keep cautery away from ETT

Do Not Play with Fire
Your Patient May Get Burned

Don’t add excessive oxygen to the Fire Triangle

Oxygen

Fuel

Ignition Source
Flash-Fire during Breast Biopsy

Follow-Up after Flash Fire
- Occurred during mask anesthesia
- Elderly patient
- “Flash-fire” reported
- Due to skin prep solution, oxygen enrichment, and cautery
- Required excision with flap closure

Facial Burns Following Flash-Fire
- During Local/MAC procedure with use of O₂ mask during procedure in the subclavian area
- Resulted in extensive 2nd and 3rd degree burns
**Burn of Shoulder Following Flash-Fire**

**Surface Fiber Flame Propagation (SFFP)**

- Oxygen coated fibers and body hair (including fine facial hair) can cause fire to sweep over surfaces
- Fire will follow the source of oxygen
- Mask is a large reservoir for oxygen

**Charred Drapes following Flash Fire**

**Do Not Take Oxygen for Granted**

- Supports combustion
- Necessary for any fire to start
- Use only as needed
- Document need
- Limit the total flow
- "Vent" excess
- Communicate with surgeon
Keep FiO2 at .3 (30%) or less
(when possible, consistent with patient’s overall status)

- Use the pulse oximetry readings to guide oxygen use
- Get a baseline before O₂ is administered
- Do not strive for saturation levels above baseline if ambient O₂ is an issue

Reduce the FiO₂

- For nasal cannula or standard O₂ mask, consider the appropriateness of connecting the devices to the Y-piece of the anesthesia circuit
- Then adjust O₂ and air flow-meters to reduce the FiO₂

Other Concerns

- Petroleum-based eye ointments should be avoided in facial surgery – used moistened saline pads
- Put water-soluble gel on body hair near surgical site
Consider Using Medical Air Whenever Possible in Local and Local / MAC Cases

Think before Using $O_2$
flow meters

- 100% oxygen is being delivered to the patient even though the patient may be inspiring much less
- The 100% $O_2$ can cause an enriched oxygen environment in the vicinity of surgery

Fire Extinguishers

- Know where they are located
- Know the type of fire
- Know how to activate and use the devices
Know where the Oxygen Shutoff is Located

• Located outside of the operating room
• Turn off if a fire becomes uncontrollable
• Use Ambu bag with air if needed to ventilate patient

Locate the Gas Shutoff Panel in Advance of Anesthesia Administration

• Usually located in hall outside of each operating room

Fire Alarms

• Know where they are located
• Activate as soon as possible – will bring the fire department
• Fires can get out of control rapidly
62"x80" wool fire blanket
Treated with Dupont X-12 for fire retardancy. (This blanket is fire retardant in accordance with the Federal Flammable Fabrics Act, CS 191-53. Machine washable.)

- Use blanket to smother flames
- However, if fire starts under drapes, in oxygen enriched environment, may not put out fire and may continue to thermally injury the patient
Types of Fire Extinguisher

• Class A extinguishers can put out fires from "ordinary combustibles" such as wood, plastic or paper.
• Class B can put out burning liquids such as gasoline or grease.
• Class C can put out electrical fires.
• Extinguishers marked A, B and C can put out all types.

Conclusions

• Assure proper control of oxygen, heat and fuel sources in the O.R.
• Be prepared to respond rapidly and appropriately to an O.R. fire
• Learn from past events, to prevent future reoccurrences