

Fire security in the operating room

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February 2011







Introduction

- Few reports
- \pm 100-650/year USA?
- 10 à 20 % severe burns
- Stable
- **More frequent during ambulatory surgery**
- Can be avoided (reduced) with a clear understanding of the mechanisms

Risk factor in ambulatory surgery

- Nr of operations
- Type of anesthesia
- Type of surgery
- Lack of drill
- Rapid turn over

Table 2. Mechanisms of Injury

	MAC (n = 121), n (%)	GA (n = 1,519), n (%)	RA (n = 312), n (%)
Respiratory event	29 (24%)†	337 (22%)	11 (4%)†
Inadequate oxygenation/ventilation	22 (18%)*†	33 (2%)*	5 (2%)†
Cardiovascular event	17 (14%)	253 (17%)	23 (7%)
Equipment failure/malfunction	25 (21%)†	199 (13%)	8 (3%)†
Cautery fires	20 (17%)*†	10 (1%)*	1 (0%)†
Related to regional block	2 (2%)†	7 (0%)	168 (54%)†
Inadequate anesthesia/patient movement	13 (11%)*†	42 (3%)*	7 (2%)†
Medication related	11 (9%)	95 (6%)	11 (4%)
Other events‡	24 (20%)*	586 (39%)*	84 (27%)

* $P < 0.025$ monitored anesthesia care (MAC) vs. general anesthesia (GA) claims. † $P < 0.025$ MAC vs. regional anesthesia (RA) claims. ‡ Other events includes surgical technique/patient condition, patient fell, wrong operation/location, positioning, failure to diagnose, other known damages, no damaging event, and unknown.

Table 5. Characteristics of MAC Claims Resulting in Burns after Electrocautery (n = 20)

Characteristic	n (%)
Aged 70 yr or older (n = 20)	7 (35)
ASA PS III-V (n = 16)	3 (19)
Head, neck, face, or biopsy* (n = 20)	19 (95)
Oxygen administration device (n = 19)	
Facemask	7 (37)
Nasal prongs	9 (47)
Unknown device	3 (16)
Oxygen flow rate, l/min (n = 9)	
< 5	5 (56)
≥ 5	4 (44)
Fuel† (n = 16)	
Drapes	13 (81)
Alcoholic prep solutions	5 (31)
Facial hair	1 (6)
Substandard care, % (n = 14)	7 (50)
Payment to plaintiff, % (n = 18)	16 (89)
Median (range of payments) (n = 16)	\$71,375 (\$8,175–321,323)

Percentages are based on claims without missing data. Denominators are listed in parentheses. Payments were adjusted to 1999 dollars using the Consumer Price Index.

* Only one procedure was not located on the head, neck, or face. It was removal of arm lesions. † Fuel was unknown in four claims. In three claims, alcohol and drapes were ignited.

ASA PS = American Society of Anesthesiologists physical status.

- The « never » events:
 - Fire
 - Wrong site surgery
 - Foreign body (instrument) left in the patient
- Medicare will soon refuse to reimburse
- Understanding of the mechanisms is of utmost important

« Recept » : the fire triad

- Ignition source
- Oxygen-rich atmosphere
- Inflammable material (fuel)
- **Always found in the O.R.**
- Everybody is concerned
- Prevention = good communication



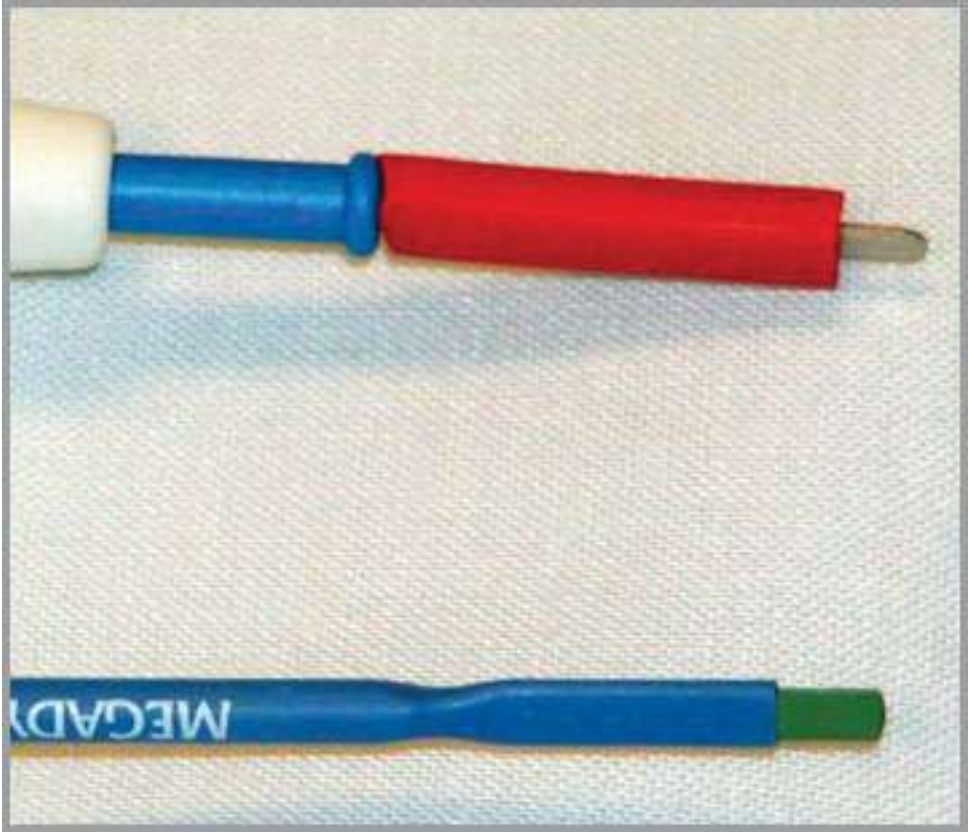
Ignition source

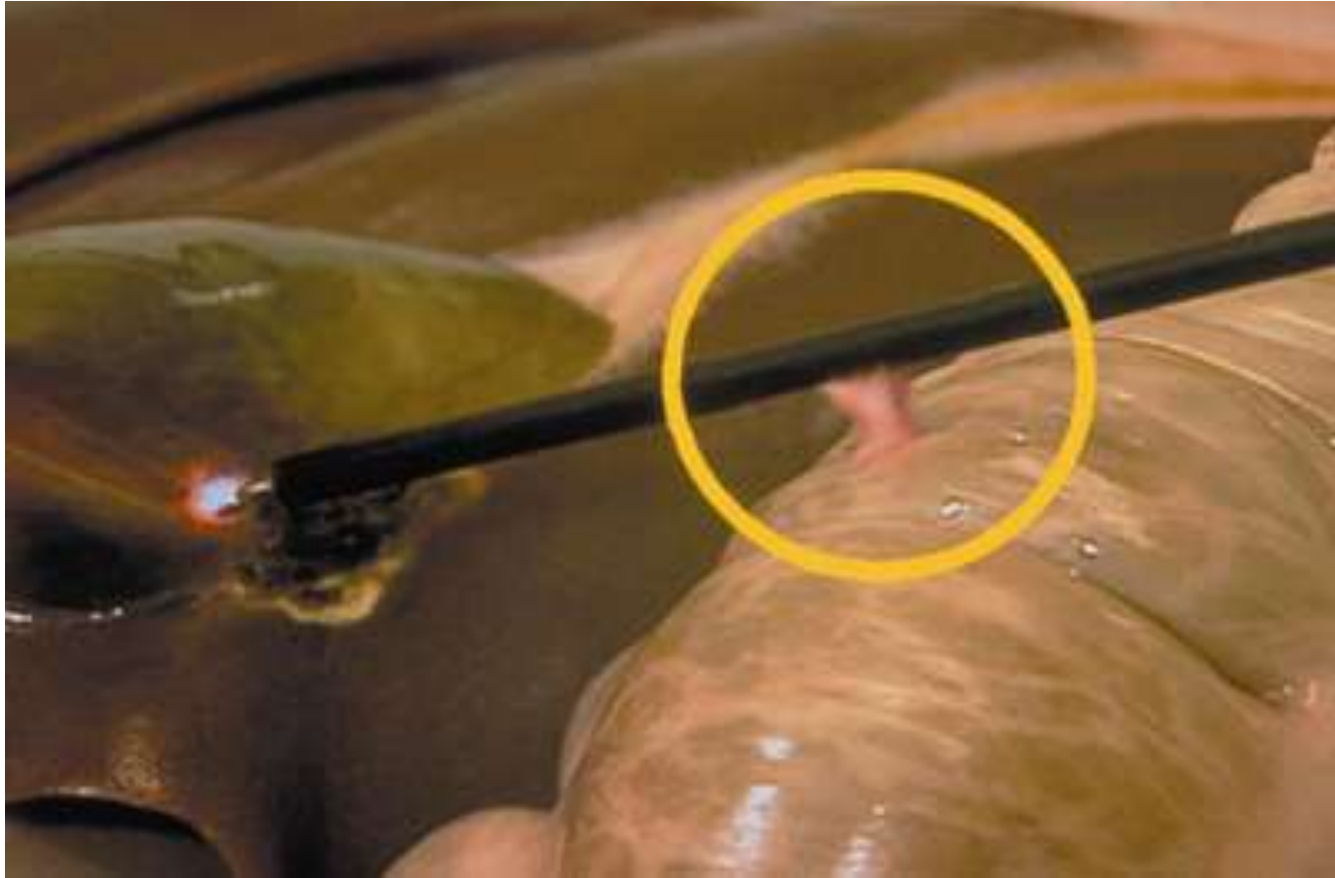


- Diathermic loop
- « Cold light »
- Laser
- Defibrillator

Ignition source (2) : diathermic loop

- Used in 85%, 100% fire during MAC (Anesthesiology, feb 2006)
- Importance of alarm maintenance
- Original insulated point *
- Single use
- Insulated holster when not in use
- « Active electrode monitoring system »**
recommended for laparoscopy





« Cold light »

K. Hindle, Surg. Endosc (2009)23;1720

- T° at the extremity of the cable: 119.5 à 268.6 °C
- Fire on the drape : 3-6 sec
- Cutaneous lesions at distance of the skin
- Proportional to the duration of contact

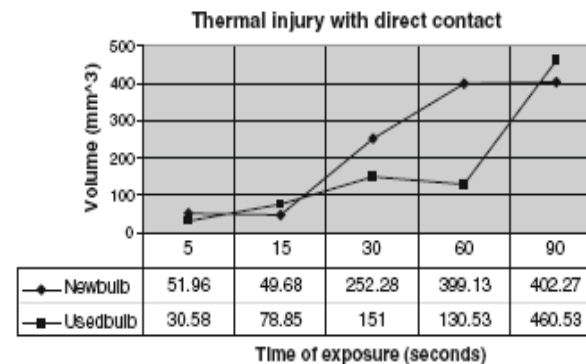
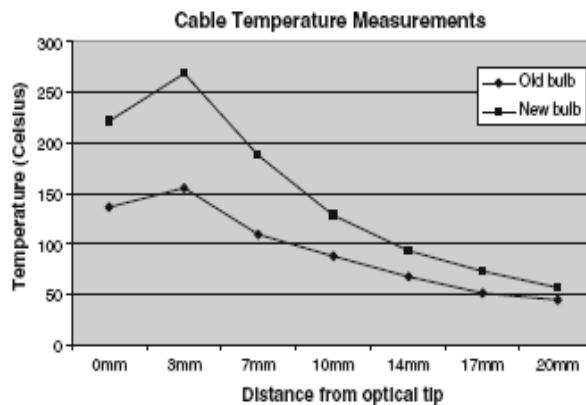


Fig. 2 Volume of injury as a function of time and bulb status

« Cold light »

Yavuz, 2006, Surg Lapar. Endosc Techn

- T° at the extremity of the laparoscope: 60-100°C
- Contact to the intestine: histological lesions after 5 sec !

Laser

- Very potent
- Ignition of drapes, hair, tubes...
- Reflection with hazardous fire (wax, mirror, surgical instruments...)

Laser and the endotracheal tube

- Use of « laser-resistant » endotracheal tube
- Fill cuff with physiological serum + methylene blue
- Communication between surgeon and anesthesiologist when a laser is used
- Reduce O₂ concentration in anesthetic gas mixture, no N₂O, wait for elimination
- Prevention : water, wet drapes, no paper drape, acoustic signal, be careful if blood on tube.....

Sources d'ignition : laser



Figure 2. Demonstration of rocket-like flames shooting from a tracheal tube caused by laser ignition of the tube with 100% oxygen flowing. Image provided courtesy of ECRI Institute.



Fuels

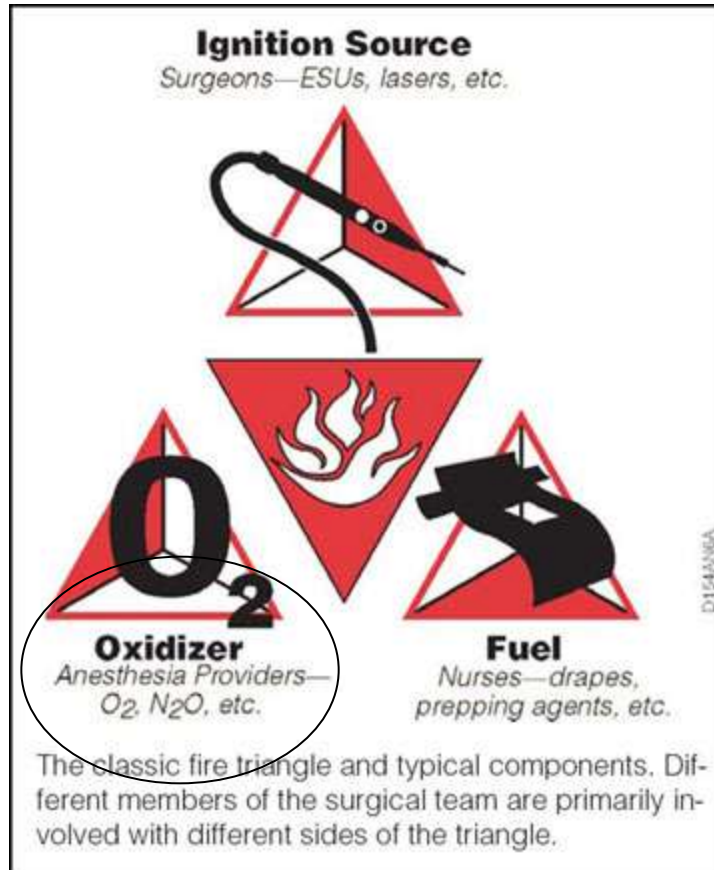
- Patient
 - Hair
 - GI gases :
- Agents : ether, acetone, aerosol spray, alcohol), dye,
- Drapes, , mask, mattress, blanket, surgical gauzes,...
- Ointment : petrolatum, paraffin
- Anesthesia circuit, mask
- Catheter
- Cuffs TA
-

Surgical Drape Flammability

(Goldberg, AANA, 2006, vol 74, n5)

- Direct Application of diathermy : no ignition
« non-flammable drapes »
- Danger if bipolar electrocautery ! (electrical arch)
- Speed of ignition related to Fi O₂

Drape	21%	35%	100%
A	7.47 ± 1.38	2.58 ± 0.63	1.54 ± 0.43
B	7.44 ± 1.5	2.61 ± 0.51	1.42 ± 0.35
C	7.41 ± 1.35	2.53 ± 0.45	1.6 ± 0.4
D	7.35 ± 1.45	2.76 ± 0.49	1.58 ± 0.49



Oxidizer

- Fire more rapid if O₂-rich atmosphere
- Drapes create « bubbles »
- Reduce FiO₂ or replace with compressed air
- Ventilate surgical field with aspiration or continuous air flow
- No N₂O
- Use cuffed tube if oral surgery
- Tracheotomy : no diathermy or stop O₂

Other ASA recommendation

- Oral surgery : continuous aspiration
- Control of drapes dressing (bubble)
- Head and neck surgery :
 - MAC : light sedation, limited O₂
 - GA : tube or LMA without gas leak
 - Hair or beard protection with gel like KY

In case of fire....

- Importance of the detection (flame, odor, smoke, sound, drape discoloration)
- Stop operation
- Stop O₂, endotracheal tube withdraw *
- Stop fire (water, physiological serum, CO₂ extinguisher)
- Stop gas inlet
- Burn care for patient
- Tube examination (fragment)
- Planning following training (drill)
- Fire resistant doors

Importance of the prevention

- Detector
- Springler
- Fire hydrant
- Extinguisher
 - Look at the type of fire : A, B, C,D, E
 - Look at the type of extinguisher : water, CO2, powder



Fire types

- Class A : wood, paper, tissue, PVC...
- Class B : oil, paint, benzine...
- Class C : gas
- Class D : metal
- E : electrical fire

Never.....

