

Episode 174: OR Fires and Electrical Safety

On this episode: Dr. Jed Wolpaw With Dr. Gillian Isaac

In this 174th episode I welcome back Dr. Gillian Isaac to discuss another 2 highly tested ABA keywords, OR fires and electrical safety in the OR.

[All keywords covered](#)

Questions & Notes

Click → jump to answers/notes.

WHAT DO I NEED TO KNOW?

High yield

FIRE TRIANGLE

Most important aspect of OR fire management?

RISK FOR AIRWAY FIRE DURING LASER RESECTION OF TRACHEAL TUMOR DECREASED IN

- A. CO₂ rather than GAD laser
- B. Helium > 60%
- C. N₂O > 60%
- D. PVC ETT
- E. Halothane in mixture

Discussion

REASONS FOR SELECTING CUFFED ETT OVER UNCUFFED INCLUDE ALL OF THE FOLLOWING EXCEPT

- A. Few intubations w/ ETT needed
- B. Less chance for airway fires
- C. Spontaneous breathing easier
- D. Aspiration of gastric contents less likely

Discussion

REDUCTION OF AIRWAY FIRE DURING LASER SURGERY OF AIRWAY BEST ACCOMPLISHED BY USE OF

- A. Continuous mode laser emissions
- B. Nitrous oxide, opioid, relaxant technique
- C. PVC ETT and cuff
- D. Topical lido
- E. Saline filled sponges over exposed tissues

Discussion

DURING SURGERY CO₂ LASERS, WHICH INHALED GAS MIXTURE IS LEAST LIKELY TO PROMOTE COMBUSTION OF ENDOTRACHEAL TUBE?

- A. O2 25%, He 75%
- B. O2 25%, N2 75%
- C. O2 25%, N2O 75%
- D. O2 50%, N2 50%
- E. O2 50%, N2O 50%

Discussion

AIRWAY FIRES

WHAT TO DO IN NON-AIRWAY FIRE?

WHAT TO DO IN AIRWAY FIRE?

“Stop O2” or “pull ETT”, which first?

DURING LASER MICROSURGERY OF LARYNX W/ ETT, FIRE OCCURS IN AIRWAY. MOST APPROPRIATE INITIAL MANAGEMENT?

- A. Decrease FIO2
- B. Saline into ETT
- C. Perform cricothyroidotomy
- D. Remove ETT
- E. Ventilate w/ air

Discussion

DURING LASER EXCISION, DARK SMOKE SUDDENLY APPEARS IN SURGICAL FIELD. TRACHEA INTUBATED, ANESTHESIA MAINTAINED W/ HALOTHANE, NITROUS, OXYGEN. MOST APPROPRIATE INITIAL STEP?

- A. Change gas to air
- B. Fill oropharynx w water
- C. Water into ETT
- D. Remove ETT
- E. Ventilate w/ CO2

Discussion

TWO HOURS AFTER SUSTAINING BURN TO HEAD/CHEST/NECK, PATIENT HAS STRIDOR AND DIFFICULTY BREATHING. MOST APPROPRIATE INITIAL MANAGEMENT?

- A. Admin aerosolized norepinephrine
- B. Admin helium oxygen
- C. Intubate
- D. Admin dexamethasone
- E. Tracheostomy

Discussion

LASER SAFETY

EYE PROTECTION FOR OR STAFF NEEDED. CLEAR WRAP AROUND GOGGLES ADEQUATE WITH WHAT KIND OF LASER?

- A. Argon

B. Nd-YAG

C. CO2

D. None of the above

Discussion

OF THE FOLLOWING LASERS, WHICH PENETRATES TISSUE MOST?

A. Argon

B. Helium neon

C. Nd-YAG

D. CO2

Discussion

SUMMARY

ELECTRICAL OR SAFETY

Foundations

If you plug in bear hugger, and LIM goes off, what should you do?

WHICH OF FOLLOWING IS INDICATED BY AN ALARMING LIM?

A. Electrical shock to patient

B. Power surge in main hospital supply

C. Disconnection of patient to electrocautery grounding pad

D. Overload of OR circuit

E. Presence of current leak between OR electrical device and ground

Discussion

LINE ISOLATION MONITOR

A. Prevents microshock

B. Prevents macroshock

C. Provides electrical isolation in OR

D. Sounds alarm when grounding occurs in OR

E. Provides safe electrical ground

Discussion

WHICH OF FOLLOWING CAUSES LIM TO ALARM?

A. Discharge static electricity

B. Flow of current to ground in isolating circuit

C. Interruption of current to electrical outlets caused by circuit breaker

D. Total electrical current exceeding circuit capacity

Discussion

IN OR

A. Conductive floors necessary for electrical safety

B. ECG monitors may be used as grounding source

C. Improperly grounded electrocautery causes VF

- D. Isolation transformer offers no protection against micro-electrocution
- E. LIM will interrupt power automatically when excess leakage to ground detected

Discussion

MACRO/MICRO SHOCK

MINIMUM MACROSHOCK REQUIRED TO DELIVER DEFIB

- A. 1mA
- B. 10 mA
- C. 100 mA
- D. 500 mA
- E. 5000 mA

Discussion

FUNDAMENTAL DIFFERENCE OF MACROSHOCK VS MICROSHOCK?

- A. Location
- B. Duration
- C. Voltage
- D. Capacitance
- E. Lethality

Discussion

LEAKAGE CURRENT AND MICROSHOCK HAZARDS HAS BEEN ELIMINATED BY

- A. Isolation transformer
- B. Conductive flooring
- C. 3-wire grounding system
- D. LIM
- E. None above

Discussion

ELECTROCAUTERY SURGICAL UNIT

REASON PATIENT NOT BURNED BY RETURN OF ENERGY FROM PATIENT TO BOVIE?

- A. Coag side is + relative to ground side
- B. Resistance in body attenuates energy
- C. Exit current density much less
- D. Overall energy delivered too small

Discussion

WHICH OF FOLLOWING DECREASES RISK FOR BURNS DURING BOVIE?

- A. Conductive flooring
- B. Grounding of patient to OR table
- C. Increase resistance of current at return electrode
- D. Isolation of current output of ESU
- E. Replacement of return electrode at distance from surgical site

Discussion

AFTER REMOVING ELECTROCAUTERY PAD FROM THIGH, BURN NOTED. WHICH OF FOLLOWING MOST LIKELY CONTRIBUTED TO INJURY?

- A. LIM fault
- B. Leak from ECG module
- C. Defective grounding of ESU
- D. Dry gel on pad
- E. Excessive current settings

Discussion

BURN FOUND AT SITE OF BOVIE PAD. WHICH OF FOLLOWING MOST LIKELY?

- A. ESU in bipolar mode
- B. Pad partially detached
- C. ESU line severed
- D. LIM alarm that patient became grounded

Discussion

TAKE HOME POINTS

What do I need to know?

1:38

Based on [ABA content outline](#):



- m. Electrical; Fire and Explosion Hazards; Basic Electronics
- 1) Source of Ignition; Static
 - 2) Prevention: Grounding, Isolation Transformers
 - 3) Macro and Micro Current Hazards
 - 4) Safety Regulations; National Fire Protection Association (NFPA) Standards
 - 5) Risk Factors for Intraoperative Fire

Basic:

- e. Electrical, Fire, and Explosion Hazards
- 1) Causes of Intraoperative Fires
 - 2) Treatment of Intraoperative Fires
 - 3) Lasers and Laser Safety

Advanced:

High yield

2:13

- Airway fire: prevention, management
- Laser safety

Fire triangle

2:44

- Fuel, oxidizer, ignition source
- OR = perfect environment

Most important aspect of OR fire management?

3:22

- Prevention
- Discuss fire risk and mgt during time out
- Biggest prevention
 - o Laser → minimize FiO₂ (source)
 - o Don't have drapes soaked in prepping agent (fuel)
 - o Cover exposed areas with water-soaked gauze

Risk for airway fire during laser resection of tracheal tumor DECREASED in

5:01

- A. CO₂ rather than GAD laser
- B. Helium > 60%
- C. N₂O > 60%
- D. PVC ETT
- E. Halothane in mixture

Discussion

5:24

- A: CO₂ is flammable
- **B. Helium decreases O₂ concentration with nonflammable mixture**
- C, D: flammable
- E. Doesn't make a diff?
- Make sure to make note of exhaled O₂ concentration when getting ready for laser, especially because if running low flows, can take a little while.

Reasons for selecting cuffed ETT over uncuffed include all of the following except

7:32

- A. Few intubations w/ ETT needed
- B. Less chance for airway fires
- C. Spontaneous breathing easier
- D. Aspiration of gastric contents less likely

Discussion

7:53

- A. From peds experience, reintubation with uncuffed tubes
- B. Less gas leak
- **C. Doesn't make sense**
- D. True

Reduction of airway fire during laser surgery of airway best accomplished by use of

9:17

- A. Continuous mode laser emissions
- B. Nitrous oxide, opioid, relaxant technique
- C. PVC ETT and cuff
- D. Topical lido
- E. Saline filled sponges over exposed tissues

Discussion

9:41

- A. Continuous doesn't sound good (vs intermittent)
- B. Discussed nitrous earlier
- C. flammable
- D. unsure
- **E. Good**

During surgery CO2 lasers, which inhaled gas mixture is least likely to promote combustion of endotracheal tube?

10:10

- A. O2 25%, He 75%
- B. O2 25%, N2 75%
- C. O2 25%, N2O 75%
- D. O2 50%, N2 50%
- E. O2 50%, N2O 50%

Discussion

10:38

- **O2 25% He 75%**
 - o He not combustible
- Can get rid of higher O2 content
- N2 is combustible

Airway fires

11:02

- Closed claims data, most are head/neck/chest and using nasal cannula. Outpatient eye places
- Most commonly from electrocautery

What to do in non-airway fire?

11:45

- Remove drapes and all flammable material, extinguish burning material
 - o If not extinguished on first attempt, use CO2 fire extinguisher

What to do in airway fire?

12:03

- Usually laser in airway.

“Stop O2” or “pull ETT”, which first?

- **Oral boards:** usually simultaneous
- **Written boards:** pull tube first

During laser microsurgery of larynx w/ ETT, fire occurs in airway. Most appropriate initial management?

13:13

- A. Decrease FIO2
- B. Saline into ETT
- C. Perform cricothyroidotomy
- D. Remove ETT
- E. Ventilate w/ air

Discussion

13:32

- D. Remove ETT as discussed above

During laser excision, dark smoke suddenly appears in surgical field. Trachea intubated, anesthesia maintained w/ halothane, nitrous, oxygen. Most appropriate initial step?

13:42

- A. Change gas to air
- B. Fill oropharynx w water
- C. Water into ETT
- D. Remove ETT
- E. Ventilate w/ CO₂

Discussion

14:06

- **D. Remove ETT!**
- Probably won't have ambiguous answer where it's pull ETT vs stop flow

Two hours after sustaining burn to head/chest/neck, patient has stridor and difficulty breathing. Most appropriate initial management?

14:53

- A. Admin aerosolized norepinephrine
- B. Admin helium oxygen
- C. Intubate
- D. Admin dexamethasone
- E. Tracheostomy

Discussion

15:15

- Don't delay intubation if difficulty breathing.
- Will likely get worse and more difficult to intubate, so do it ASAP.

Laser safety

15:45

- Lasers are major cause of airway fires.
- Use appropriate laser safe ETT.
- Laser protection required.
- **CO₂** – **CO**rnea injuries
- YAG – retina (further than cornea)

Eye protection for OR staff needed. Clear wrap around goggles adequate with what kind of laser?

16:25

- A. Argon
- B. Nd-YAG
- C. CO₂
- D. None of the above

Discussion

16:39

- Memorization question
- **CO₂. CO**rneal. Clear.

Of the following lasers, which penetrates tissue most?

16:59

- A. Argon
- B. Helium neon
- C. Nd-YAG
- D. CO₂

Discussion

17:11

- Not CO₂ bc superficial to cornea.
- YAG laser goes deeper – most - **C**

Summary

17:40

- Fire / laser safety questions will be on
 - o Fire triangle
 - o Fire prevention
 - o OR fire treatment
 - o Laser safety

Electrical OR safety

18:40

- ABA content outline. More basic, unlike fire
- Prevention: grounding, isolation transformers
- Micro and macro current hazards
- Most commonly line isolation monitor

Foundations

19:58

- Electricity needs to travel through circuit. Needs to be continuous.
 - o Electric company → wires → circuit breaker → house → returns to ground (“wire”)
 - Thus standing on ground, you serve as part of circuit
- OR: electricity doesn’t return through ground. Isolated circuit!
- If plug in faulty equipment, OR circuit converts to normal ‘house-like’ circuit: isolated → grounded

21:57

- Line isolation monitor: alert when circuit becomes grounded

If you plug in bear hugger, and LIM goes off, what should you do?

22:43

- Unplug it and keep working backwards to figure out faulty equipment

Which of following is indicated by an alarming LIM?

22:55

- A. Electrical shock to patient
- B. Power surge in main hospital supply
- C. Disconnection of patient to electrocautery grounding pad
- D. Overload of OR circuit
- E. Presence of current leak between OR electrical device and ground

Discussion

23:15

- Key point of isolated circuit doesn’t have connection to ground.
- LIM will tell you when isolated circuit becomes grounded. **(E)**

Line isolation monitor

23:58

- A. Prevents microshock
- B. Prevents macroshock
- C. Provides electrical isolation in OR
- D. Sounds alarm when grounding occurs in OR
- E. Provides safe electrical ground

Discussion

24:13

- Just monitor, so alarm when grounding occurs (**D**)

Which of following causes LIM to alarm?

24:20

- A. Discharge static electricity
- B. Flow of current to ground in isolating circuit
- C. Interruption of current to electrical outlets caused by circuit breaker
- D. Total electrical current exceeding circuit capacity

Discussion

24:38

- All about monitor reaching ground (**B**)

In OR

24:53

- A. Conductive floors necessary for electrical safety
- B. ECG monitors may be used as grounding source
- C. Improperly grounded electrocautery causes VF
- D. Isolation transformer offers no protection against micro-electrocution
- E. LIM will interrupt power automatically when excess leakage to ground detected

Discussion

25:17

- We know E not correct because only alarm.

- A sounds terrible.
- B – doesn't sound like its design.
- C is such a general statement making it a poor choice.
- **D unsure but left with it. Won't protect.**

Macro/micro shock

26:23

- Not international standard.
- Microshock – imperceptible. 10-100 μ A applied directly to heart muscle \rightarrow disrupt normal function.
 - o Likely w/ things with direct line to heart like central line or pacemaker electrodes
- Macroshock – larger current through body, not passing directly to heart muscles

Minimum macroshock required to deliver defib

27:19

- A. 1mA
- B. 10 mA
- C. 100 mA
- D. 500 mA
- E. 5000 mA

Discussion

27:38

- Answer is 100 mA
- 1 mA – threshold of perception
- 10-20 A – electrocurrent
- > 20m A – all muscles contract down and can't let go

Fundamental difference of macroshock vs microshock?

28:30

- A. Location
- B. Duration
- C. Voltage
- D. Capacitance
- E. Lethality

Discussion

28:38

- Location, location, location!
- Is it directly on heart.
- Voltage is tricky. This is just a potential difference between 2 ends.

Leakage current and microshock hazards has been eliminated by

29:29

- A. Isolation transformer
- B. Conductive flooring
- C. 3-wire grounding system
- D. LIM
- E. None above

Discussion

29:45

- Eliminated is strong word.
- LIM is only monitor.
- **Answer is E: isolation transformer is layer of safety.**

Electrocautery surgical unit

30:32

- Bovie - one line to Bovie itself. Concentrated current at tip → dissipated and travels through grounding pad to ESU
- Can get burns if pad not on all the way.
 - Current can concentrate where it's stuck on.
 - If gel is dry because not drawing the current adequately

Reason patient not burned by return of energy from patient to Bovie?

31:20

- A. Coag side is + relative to ground side
- B. Resistance in body attenuates energy
- C. Exit current density much less
- D. Overall energy delivered too small

Discussion

31:39

- C - reason for having large pad compared to Bovie tip.
 - o Spreading over larger surface area.

Which of following decreases risk for burns during Bovie?

31:53

- A. Conductive flooring
- B. Grounding of patient to OR table
- C. Increase resistance of current at return electrode
- D. Isolation of current output of ESU
- E. Replacement of return electrode at distance from surgical site

Discussion

32:15

- A: can get rid of some
- B: don't want to ground to table
- C: ↑ resistance would build up heat.
- D: wouldn't want to isolate. Want to make circuit
- **E**

After removing electrocautery pad from thigh, burn noted. Which of following most likely contributed to injury?

32:58

- A. LIM fault
- B. Leak from ECG module
- C. Defective grounding of ESU
- D. Dry gel on pad
- E. Excessive current settings

Discussion

33:19

- If not on all the way or if gel dry, can cause burns **(D)**

Burn found at site of Bovie pad. Which of following most likely?

33:28

- A. ESU in bipolar mode
- B. Pad partially detached
- C. ESU line severed
- D. LIM alarm that patient became grounded

Discussion

33:51

- B – not as wide distribution.

Take home points

- LIM only a monitor for grounded current.
 - o Unplug last thing.
 - o Only detect current link to ground.
- Difference of micro/macro is location.
 - o Microshock has direct conduit to heart.
- VFib
 - o Micro: 100 μ A
 - o Macro: 50-100 mA
- Can have burns if Bovie pad not on correctly

What are you doing to take mind off stressful time?

Wolf Hall – historical novel by Hillary Mantel

Resident story: Taking care of COVID patient who was intubated, severely ill, with a 6-year-old child. Resident and team has been helping the child Zoom in with patient. Once extubated, resident helped make surprise zoom call to child and family, when they were able to talk to patient after 2 weeks.

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