

## Surgical Fires and Patient Surgical Burns

By Joseph M. DeRosier, PE, CSP, NCPS program manager

**WHY NOW?** Why is so much attention being focused on surgical room fires? For a number of reasons — primarily, because these types of fires are a potentially devastating yet preventable adverse event.

The Joint Committee on Accreditation of Healthcare Organizations (JCAHO) recently issued a sentinel event alert (Issue 29, June 24, 2003) on surgical fires. ECRI, an independent non-profit health services research agency, dedicated the January 2003 edition of their magazine, *Health Devices* (Volume 32, Number 1), to surgical fire safety. Fires in the operating room (OR) are not frequent. According to ECRI, only 50-to-100 surgical fires are reported each year — but the fires can result in serious consequences to patients, damage to equipment and interruptions to operations.

Eleven reports of fires or burns to patients occurring within the OR were reported by VHA during 2002. Six of these events were fires; the remainder were reports of thermal burns to patients from direct contact with a device, such as a bovie. We have often stated that what gets reported and what actually occurs are two different issues. As Dr. Bagian has said, "We don't know whether we're looking at the tip of the iceberg or the snowflake on the tip of the iceberg." However, we are able to draw some conclusions and make recommendations based upon reported events and the available literature.

As a reminder, here is a brief review of the three conditions that must be in place for a fire to occur: something to burn (flammable or combustible material), the presence of oxygen, and an ignition source. When brought together, these components complete the fire triangle (see Figure 1 below). Preventing a fire in the OR can be achieved by controlling the elements that make up the fire triangle.

### Control Ignition Sources

The most common ignition sources in the OR are electro-surgical and/or electrocautery equipment and lasers. ECRI reports that approximately 68% of surgical fires involve electro-surgical equipment and 13% involve lasers. VHA root

cause analysis and safety report data reveal that all of the OR fires and patient burns reported during 2002 resulted from the use of electrocautery and electrosurgical equipment; no reports of fires resulting from the use of lasers were submitted.

The good news — we have control over ignition sources.

*ECRI recommends that during electrosurgery:*

- ◆ Remove unneeded foot switches to avoid inadvertent activation.
- ◆ Place the electrosurgical pencil in its holster when not in active use and place the electrosurgical unit in the standby mode.
- ◆ Allow the tip of the pencil to be activated only by the individual wielding it and when it is under direct observation of the surgeon.
- ◆ Use only active electrode tips that are manufactured with insulating sleeves.
- ◆ Do not use electrosurgery to enter the trachea.
- ◆ Do not use electrosurgery in close proximity to combustible materials and oxygen-rich atmospheres.
- ◆ Dispose of electrocautery pencils properly. For example, break off the cauterizing wire and cap the pencil.

*ECRI recommends that during laser surgery:*

- ◆ Limit laser output to the lowest clinically acceptable power density and pulse duration.
- ◆ Place the laser in standby mode when it is not in active use and activate it only when the tip is under the surgeon's direct vision. Only permit the person using the laser to activate it.
- ◆ Use surgical devices designed to minimize laser reflectance.
- ◆ Take steps to eliminate/minimize damage to the laser fibers by not clamping the fibers to drapes; and when performing surgery through endoscope, pass the laser fiber through the endoscope before introducing the scope into the patient.
- ◆ Use appropriate laser-resistant tracheal tubes during upper airway surgery and follow directions on the label and in the literature regarding product use. This might include use of dyes in the cuff to indicate a puncture,

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What is a fire? The definition of fire used in the fire protection community is "a rapid, self-sustaining oxidation, emitting smoke, heat, or light"

Combustible/Flammable Material  
(Drapes, sponges, fabrics, equipment, antiseptics/wipes, body hair, gases, tubes, hoses, clothing/garments, flammable/combustible liquids)



Oxygen [Air (21% oxygen), FiO2, compressed O2 supplied via cylinders or wall (piped) outlets, nitrous oxide]



Ignition Source (Electrocautery and electrosurgical equipment, lasers, lights, defibrillators, and electrical equipment)

Figure 1

# The Rationale Behind the Five Steps of the Ensuring Correct Surgery Directive

By Noel E. Eldridge, MS, NCPS executive assistant

THE ENSURING CORRECT SURGERY DIRECTIVE went into effect Jan. 1, 2003. The directive was designed to provide VHA with a process that would be effective in ensuring correct surgeries, as well as being compatible with the work process. Results to date are encouraging — through June 2003 there have been no cases reported to NCPS in which the directive was followed and an incorrect surgery resulted. Nonetheless, many questions have been asked concerning the rationale behind the directive's steps. Here is a summary rationale for each of the five steps:

- 1) *Consent form requirements.* Looking at Root Cause Analyses (RCAs) submitted prior to 2003 that were associated with incorrect surgeries or invasive procedures, a significant fraction indicated that the consent process was a contributing factor. For instance, crucial information like the site or side of the procedure was left off or incorrect. Our 2002 analysis indicated that approximately 45% of incorrect surgeries could be averted if the consent form had provided the full name of the patient, the site, the side, the name of procedure, and the reason for the procedure, using language that the patient or surrogate understood.
- 2) *Marking the site.* This is a step recommended by many organizations, including the American Academy of Orthopedic Surgeons, and the Association of Perioperative Registered Nurses. Marking most sites has not been questioned. The rationale for marking sites on the midline of the trunk has been questioned. There are three basic reasons to mark all sites: (1) marking all sites ensures that there is always an indication of where the procedure is to be performed - midline procedures, especially urologic procedures, have not been impervious to wrong site mistakes; (2) to help prevent patient misidentification and mix-ups after correct identification; and (3) to bring the patient and surgeon face-to-face before the operation. This step may even help prevent incorrect procedures at the correct site.
- 3) *Patient identification.* Statements such as "the patient confirmed their identity" have been seen in multiple wrong-patient RCAs. It became clear that a patient answering "yes" or "uh-huh" is not always adequate to confirm identity. This communication gap can be addressed when a patient states their name, their SSN or birth date, as well as indicating the site of the procedure

to operating room (OR) staff. Our review of RCAs indicated that this step would have prevented about 75% of the incorrect procedures.

- 4) *"Time-out" in the OR.* Like marking sites, this step is advocated by many organizations. It provides a quiet moment to focus on verifying the correct patient, site marked, procedure to be performed, and implant needed. Plans are stated aloud and the surgeon, anesthesia provider and circulating nurse verbally agree. This ensures that there is agreement on what the OR team will do.

The poster is titled "Ensuring Correct Surgery in the Veterans Health Administration" and is organized into five columns representing different stages of the surgical process. Each column includes a checklist of requirements and small illustrative images. The columns are: 1) "Days to hours before surgery" (Step 1: Consent Form, Step 2: Mark Site), 2) "Just before entering OR" (Step 3: Patient Identification), 3) "Immediately prior to surgery" (Step 4: "Time Out"), and 4) "Step 5: Imaging Data". The poster also includes the NCPS logo, a date of October 28, 2003, and a URL for more information.

To view and print an 8.5x11 image of this poster, go to <http://vaww.ncps.med.va.gov/CorrectSurgeryPoster.pdf> or <http://www.patientsafety.gov/CorrectSurgeryPoster.pdf>.

- 5) *Checking imaging data.* Several RCAs describing incorrect surgeries indicated that needed images were not available or that the image present was incorrect to the patient or procedure. The directive requires that if images will be used to confirm a site, that at least two of the OR team confirm that images are present, correct, and properly labeled.

The detailed directive is available on-line at <http://vaww.ncps.med.va.gov/CorrectSurgDir.pdf> and <http://www.va.gov/publ/direc/health/direct/12002070.doc>.

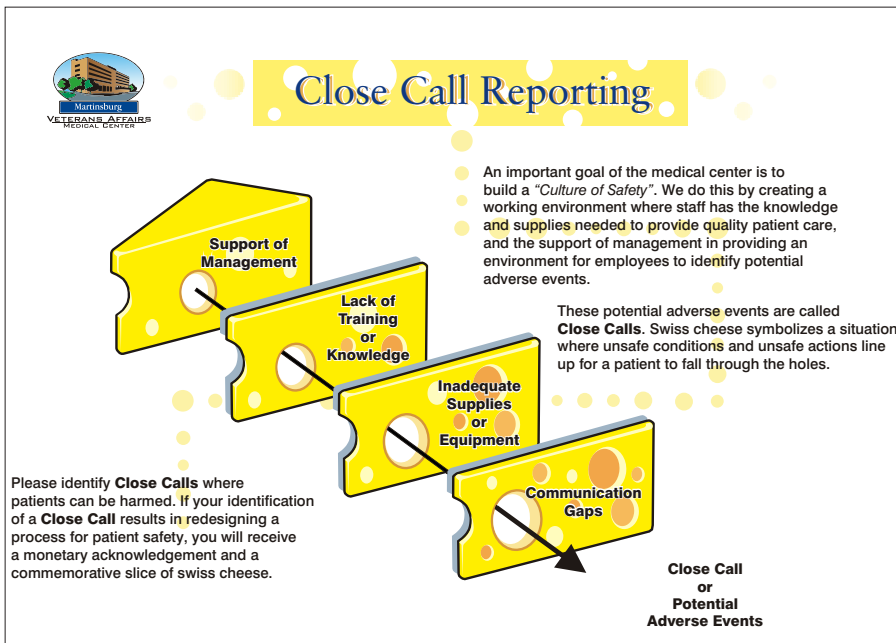
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## Martinsburg VA Medical Center Launches Close Call Reporting Program




Poster above courtesy of Martinsburg VA Medical Center

THE MARTINSBURG VA Medical Center inaugurated a Close Call Reporting Program February 2003. Using a modified "Reason's Swiss Cheese Model," Associate Medical Center Director/Nursing Geraldine A. Coyle, RN, Ed.D., CNAA, has presented this program to all levels of staff, veterans and volunteers.

Staff members are encouraged to make submissions and are recognized for them. They may call, e-mail, submit a Report of Contact, or complete an Incident Report to the Quality Management/Patient Safety Coordinator for review. The coordinator and the risk manager review the submissions prior to presenting them to Dr. Coyle and Linda J. Morris, M.D., chief of staff, who determine whether a close call has occurred.

Those who submit close calls are eligible for a \$500 cash award when a system redesign is affected. All submitters are presented a commemorative slice of Swiss cheese and a certificate by the director at quarterly all-employee meetings.

Staff members have enthusiastically embraced this program as part of the medical center's Culture of Safety. 

## Power Failures in the Operating Room Suite During Open Heart Surgery

By Bryanne Patail, BS, MLS, NCPS biomedical engineer

NCPS RECEIVED REPORTS from two VA facilities this year regarding the loss of electrical power in the operating room (OR) suite during open heart surgery.

In the first facility, the isolation transformer simply could not handle the load of all the devices brought in for the procedure. This is not unusual in older facilities or facilities that have not gone through an upgrade of their electrical power distribution system. The solution to this particular problem was to provide a higher-rated isolation transformer for that specific OR suite.

There are specific requirements and recommendations in the VA Electrical Design Manual on the proper power rating of Isolated Power Systems (IPS) for OR suites. To find the manual, click to [http://vaww.va.gov/facmgt/standard/manuals\\_elec.asp](http://vaww.va.gov/facmgt/standard/manuals_elec.asp) and then open "Hospital Projects."

Circuit breakers at the second facility opened (tripped) while a patient was on a cardio pulmonary by-pass machine. The Uninterruptible Power Source (UPS) activated to provide backup power, but also tripped its breakers. The UPS' batteries were weak and past their life expectancy.

Investigation by an independent contractor revealed the reason for the initial loss of power: The insulation on an extension cord had broken down due to mechanical damage from equipment rolling over it, resulting in a short circuit.

Based on these two incidents and similar incidents that have been investigated or reported in the past few years, the following should be considered:

(1) Ensure that a multidisciplinary team periodically evalu-


ates the IPS and UPS (if installed) in the OR suite to determine if the isolation transformer has the appropriate rating for the types of procedures the suite is used for; also, that the UPS is appropriately matched for the application.

(a) At a minimum, the team should be drawn from two sources: first, plant facilities and engineering staff, to include electrical engineers, biomedical engineers and biomedical technicians; and second, from the OR staff, to include surgeons and nurses.

(b) The team should simulate the actual setup of a specific procedure, noting the number of electrical receptacles on each wall, the location of each electrical device, and which electrical receptacles the devices might be plugged into without having to use extension cords.

(2) If UPS is an integral part of the electrical system, verify that it will be available and effective when needed. This may be accomplished through a preventive maintenance program, to include routine testing.

(3) Extension cords should not be used for a number of reasons: (a) they have a high incidence of being improperly sized for the electrical load, especially if they are serving more than one device at a time; (b) they often serve as the only cable that crosses the path between the wall and the table, thus increasing exposure to wheeled traffic, resulting in insulation breakdown which can cause a short circuit; and (c) they present a trip hazard.

If feasible, receptacles should be strategically placed (in booms, under the table, etc.) to alleviate the need for these cords. 

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use of saline fill to prevent cuff ignition, and immediate replacement of the tube if the cuff is punctured.

- ◆ Place wetted gauze or sponges adjacent to the tracheal tube cuff and keep them wet, and keep gauze or sponges wet when used with uncuffed tracheal tubes.
- ◆ Keep all moistening sponges, gauze, pledgets and their strings moist throughout the procedure.
- ◆ Consider using towels soaked in saline or sterile water around the operative site.

### **Control Oxygen Levels**

We control oxygen-rich environments in the OR, which include any atmosphere where there is greater than 21% oxygen. Why is this important? While oxygen will not burn or explode, it can cause materials that will not ignite or that burn slowly in ambient air to easily ignite and burn rapidly. The vapor density of pure oxygen (1.1) is slightly heavier than air. This means that pure oxygen may collect in depressions or under drapes or clothing.

Nitrous oxide use can increase effective oxygen levels above 21%. Like oxygen, nitrous oxide also has a vapor density greater than 1.0. With a vapor density of 1.53, it will collect in low-lying areas as well.

ECRI data shows that 74% of the reported surgical fires occurred when oxygen levels were elevated above 21%. Of the surgical fires reported in VHA during 2002, elevated oxygen levels were a contributing factor in three of the six fires. It's important to understand that oxygen may collect and its concentration become elevated: under surgical drapes; in clothing; on the surface of the skin, due to the presence of vellus; and around masks, tubes or nasal cannula when patients are provided oxygen or nitrous oxide from compressed gas cylinders or piped medical gas systems.

To control oxygen concentration levels ECRI recommends:

- ◆ That the requirement for 100% oxygen for open delivery to the face (for example, when using nasal cannula) be questioned if a lower concentration is consistent with the patient needs.
- ◆ Stopping supplemental oxygen at least one minute before using electrosurgery, electrocautery or laser surgery on the head or neck.
- ◆ Titrating the delivery of oxygen to the patient based on the patient's blood-oxygen saturation.
- ◆ Tenting drapes to allow gases to drain away from the operating table.
- ◆ Using a properly applied incise drape, if possible, to help isolate head and neck incisions from oxygen-rich atmospheres.
- ◆ Considering use of active gas scavenging of space beneath the drapes during oxygen delivery. When scavenging under the drapes, exercise caution so that the space beneath the drapes does not collapse.
- ◆ Avoiding the use of nitrous oxide during bowel surgery.

During oropharyngeal surgery ECRI also recommends:

- ◆ Suction be used as near as possible to any potential breathing gas leaks to scavenge the gases from the oropharynx of an intubated patient.

### **Control Combustible Materials**

Combustible materials — fuel that will burn — surround the patient in the OR and include: the operating table bedding, headrests, clothing, straps, towels, drapes, sponges, dressings, hair, intestinal gases, tracheal tubes, body tissue, bronchoscopes, breathing systems, petroleum jelly, adhesives, hoses and equipment covering — and this list is not all inclusive. Flammable and combustible liquids are also present in the OR,

including skin prep solutions, tinctures, degreasers, suture pack solutions and liquid wound dressings.

Understanding what can burn and what liquids are flammable or combustible is the first step in managing the fuel load for a potential fire. Allow flammable liquid preps (e.g., preps that are alcohol-based or contain acetone) to fully dry before draping; avoid pooling the liquids when they are applied. Be aware that pooled liquids can be wicked up into sponges, drapes, etc., and may take longer to dry. ECRI recommends that facial hair (e.g., eyebrows, beards and mustaches) be coated with a water-soluble surgical lubricating jelly to inhibit combustion.


### **Know and Practice the Fire Plan**

Service-specific fire plans have been required for many years. We strongly recommend that the fire plan for surgical service be reviewed annually and that quarterly fire drills be conducted. It is recommended that surgical staff members participate in at least one fire drill (conducted in the OR) every year, and it is especially important to:

- ◆ Talk about what each OR team member will do if presented with a fire involving a patient.
- ◆ Walk through the plan and look for areas where response can be improved.
- ◆ Know who will be responsible to move the patient, where the patient will be moved, and who will be moving critical equipment.

### **Not All Burns Are External**

Not all fires and burns are external to the patient. Internal fires have been reported in the literature involving patients undergoing laparoscopic procedures due to oxygen-rich atmospheres (oxygen was mistakenly used for insufflation instead of carbon dioxide). They have also been due to the use of lasers and non-metallic endotracheal tubes that were ignited while in the patient. The burning endotracheal tube created a fire similar to that which might have occurred had a blowtorch scorched the lungs.

Stray electrosurgical burns can cause internal injury that may be difficult to detect because they may not be visible to the surgeon. "Figures show that 67% of stray electrosurgical burns go unnoticed during surgery and that 25% of the patients who suffer internal injuries stemming from these burns during laparoscopic procedures die."<sup>4</sup> Insulation failure on the electrosurgical device that results in burns and capacitive coupling is cited as being the primary cause of burns during laparoscopic procedures. With use, the tip of the ESU can become extremely hot and, if inadvertently touched to targeted tissue, can cause burns. Capacitive coupling can occur if there is microscopic insulation failure in the device. The insulation failure provides an alternate electrical current path between the active electrode and the patient return electrode resulting in the burn. To minimize capacitive coupling, use an electrosurgical waveform with the lowest voltage necessary to achieve the desired surgical effect.<sup>5</sup> Instruments that use active electrode monitoring technology (AEM) are also effective to prevent capacitive coupling.<sup>4</sup> These devices are shielded and monitored so 100% of their power is delivered where intended. 

### **Bibliography**

1. Electrosurgical Burns and Fire Occurrences. (June 2003). *NYPORIS News & Alert*, Department of Health, Issue 13.
2. Focus on Surgical Fire Safety. (January 2003) *Health Devices*, Vol. 32, No. 1.
3. Preventing Surgical Fires. (June 24, 2003). *JCAHO Sentinel Event Alert*, Issue 29.
4. Werner, C. (June 2002). Guarding against an unseen killer: stray electrosurgical burns. *Healthcare Purchasing News*.
5. Performance and Safety Issues Related to High Voltage, Innovations in Electrosurgery, [http://www.valleylabeducation.org/ES\\_YTT/pages/inmo\\_11.htm](http://www.valleylabeducation.org/ES_YTT/pages/inmo_11.htm)
6. Avoiding Electrosurgical Injury During Laparoscopy: An Emerging Patient Safety Issue. (August 1997) [Videotape] Washington: Communicore.