Guidance Article

Surgical Fire Safety

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We’re now accepting applications for the first annual Health Devices Achievement Award. See page 75 for details.
Executive Summary

Featured in This Issue . . .

Surgical Fire Safety

A surgical fire is a fire that occurs on or in a surgical patient. Although such fires are rare—they occur in only an extremely small percentage of surgical cases—the actual number of incidents may surprise many people. ECRI estimates that 50 to 100 or more surgical fires occur each year in the United States alone. (ECRI itself receives, on average, one or two reports of surgical fires each week. See “Surgical Fire Data” on page 47.)

Fortunately, through awareness of the hazards and by consistently following safe practices, virtually all surgical fires can be prevented. In this month’s feature article, which starts on the next page, we provide information that can serve as the foundation for a comprehensive surgical fire prevention program.

A new focus on surgical fire safety initiatives. The risk of a surgical fire exists whenever and wherever surgery is performed, and the consequences can be devastating. Nevertheless, surgical fire safety has not always received sufficient attention in patient safety initiatives over the past 30 years. Now, however, an increasing number of organizations—from JCAHO to state departments of health to individual hospitals—are incorporating surgical fire safety into formal patient safety initiatives. ECRI considers this to be a key step in decreasing the incidence of surgical fires.

What all surgical staff need to know. Preventing surgical fires requires that all surgical team members be aware of the risks and take steps to minimize those risks. Following are just a few examples of the recommendations detailed in this month’s Guidance Article:

- **Controlling ignition sources.** Ignition sources provide the heat energy that can start a fire. According to ECRI’s analyses, about 70% of all surgical fires involve electrosurgical equipment as the ignition source. Other known ignition sources include surgical lasers, electrocautery units, and fiberoptic light sources. Recommended practices for managing ignition sources include activating an electrosurgical unit or laser only when the active tip is in view and stopping the delivery of supplemental oxygen (when clinical conditions permit) before a possible ignition source will be used in the vicinity.

- **Controlling oxidizers.** Oxidizers are gases such as oxygen (O₂) and nitrous oxide (N₂O) that support or vastly enhance combustion. Staff can help prevent fires by recognizing that O₂- and N₂O-enriched atmospheres can vastly increase the flammability of potential fuels and by taking steps to minimize the oxidizer concentration in the vicinity of any possible ignition source.

- **Managing fuels.** A wide variety of fuels are present in the surgical setting. Examples include surgical drapes, alcohol-based skin preps, tracheal tubes, and the patient’s hair. The risks of igniting these fuels can often be minimized by taking steps to reduce their flammability. For example, flammable liquid preps should be allowed to dry fully before draping to permit vapors to dissipate.

Also in This Issue

Arrhythmia analysis Q&A. Some cardiac monitors analyze a patient’s heart rhythm to alert clinicians to potentially life-threatening arrhythmias. Most devices perform this process by detecting beats, classifying them, and then comparing sequences of classified beats to stored criteria that define arrhythmia types.

As detailed in the article beginning on page 67, properly using arrhythmia analysis devices can improve their effectiveness, but the current technology has some inherent limitations that prevent devices from being 100% accurate. Despite this, ECRI does not recommend making the particular algorithm a manufacturer employs a significant purchasing criterion. No one algorithm has been proven to be superior to others overall, and the clinical effectiveness of a cardiac monitor is not solely determined by the algorithm it uses.

Problem reports. Reports describing broken chest supports on spinal tables and overheated components on a hemodialysis unit start on page 71. ♦

Will You Be the Winner?

ECRI is pleased to announce that it is introducing the Health Devices Achievement Award. This annual award will be presented to a member healthcare facility that demonstrates excellence in the field of health technology management. To learn more—and to find out how you can apply for consideration—turn to the inside back cover. ♦
Surgical Fire Safety

Summary. A surgical fire is a fire that occurs on or in a surgical patient. Such fires are rare—they occur in only an extremely small percentage of surgical cases. Nevertheless, the actual number of incidents that occur each year may surprise many healthcare professionals. ECRI estimates that 50 to 100 or more surgical fires occur each year in the United States alone. And such fires can have devastating consequences, not only for the patient, but also for the surgical staff and for the healthcare facility.

Fortunately, through awareness of the hazards—and with emphasis placed on following safe practices—virtually all surgical fires can be prevented. Thus, it’s important that surgical fire safety be incorporated into formal patient safety initiatives.

In this article, we describe a few surgical fire patient safety initiatives that have been instituted in recent years. In addition, we describe in detail the causes of surgical fires and the preventive measures that are available for healthcare personnel to follow. In addition, we review how staff should respond in the event of a surgical fire.
A New Focus on an Old Hazard
The risk of a surgical fire—a fire that occurs on or in a surgical patient—is present whenever and wherever surgery is performed, whether in an operating room (OR), a physician’s office, or an outpatient clinic. The consequences of such fires can be grave: Patients can be killed, staff can be injured, and critical equipment can be damaged.

Fortunately, surgical fires are rare: They occur in only an extremely small percentage of surgical cases. Nevertheless, the actual number of incidents that occur each year may surprise many healthcare professionals and hospital administrators. In a January 2003 Health Devices Guidance Article, ECRI estimated that 50 to 100 or more surgical fires occur each year in the United States alone.* At that time, we noted that the frequency of surgical fires was generally comparable to that of other rare surgical misadventures, such as wrong-site surgery. Yet surgical fires had often received little attention in patient safety initiatives.

It is encouraging to note, however, that the situation appears to be changing. An increasing number of organizations are incorporating surgical fire safety into formal patient safety initiatives. Such endeavors help to spread surgical fire prevention information, and they help to put policy into practice at the front lines of patient care. We mention a few such initiatives below.

In subsequent sections of this article, we describe the causes of surgical fires, detail the preventive measures that healthcare personnel should follow, and review how staff should respond in the event of a surgical fire.

Through awareness of the hazards—and with emphasis placed on following safe practices—virtually all surgical fires can be prevented.

Surgical Fire Safety Initiatives
A Hospital-Based Initiative
At least one health system has recently heightened its clinicians’ awareness of the risks of surgical fire by adding a “Surgical Fire Risk Assessment Score” to its perioperative forms for verifying the surgical site and patient identification (Mathias 2006). The initiative at this healthcare system has served to stimulate collaborative communication among surgical team members.

JCAHO’s Initiatives
In June 2003, the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) published a Sentinel Event Alert describing the risks of surgical fires and noting the importance of surgical fire prevention and education. This alert, which was developed with assistance from ECRI, noted the root causes of surgical fires and described risk-reduction strategies.

JCAHO further highlighted the issue when it announced that its National Patient Safety Goals (NPSGs) for 2005 would include a goal to “reduce the risk of surgical

Spread the Word
Surgical Fire Prevention Requires a Team Effort
The information presented in the accompanying Guidance Article is vitally important for virtually all operating room staff, particularly members of the surgical team. Please make sure the surgical staff in your facility are aware of this information by passing them your copy of Health Devices, by ordering additional copies from ECRI, or by referring staff members to this article on our Web site. Web access is free for all employees of member hospitals; all that is required is an individual username and password, which can be obtained by contacting ECRI’s Help Desk at +1 (610) 825-6000, ext. 5555, or helpdesk@ecri.org. Spreading the word can help prevent injury and save lives.
fires” in ambulatory care and office-based surgery. This goal, which largely mirrors the recommendations in the 2003 Sentinel Event Alert, specifies education for all surgical staff “on how to control heat sources and manage fuels,” and it requires establishing “guidelines to minimize oxygen concentrations under [surgical] drapes” (JCAHO 2004). This goal was retained for ambulatory care and office-based surgery for 2006. Although meeting this goal is not an accreditation requirement for hospitals, ECRI believes that hospitals should nonetheless adopt the goal as a means to help improve patient safety.

Accreditation-based initiatives like JCAHO’s goals may ultimately prove to be the most effective means of communicating the lessons of surgical fire prevention. Although the hundreds of articles published on this topic

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**Surgical Fire Data**

ECRI typically receives, on average, one or two reports of surgical fires each week. However, the actual number of incidents that occur cannot be easily quantified. There is no agency, center, or comprehensive database that has complete information on the occurrence of surgical fires.*

Nevertheless, based on accounts of fires—including published accounts and incidents described to ECRI by involved parties—and on our analyses of data in the U.S. Food and Drug Administration’s medical device reporting databases, ECRI has developed the following estimates about surgical fires in the United States (though of course surgical fires are a problem worldwide):

**Number.** Estimates of the number of surgical fires in the United States each year range from 50 to 100 or more.

**Type of equipment involved.** About 70% of surgical fires involve electrocautery equipment as the ignition source. Another 10% involve lasers. The balance of fires are ignited by a variety of other heat sources, including electrocautery (hot-wire cauterization) equipment, fiberoptic light sources, defibrillators, and high-speed burs (which can produce sparks).

**Oxidizers and fuels.** Oxygen-enriched atmospheres are reportedly involved in about 75% of surgical fires. Alcohol-based surgical preps are involved in about 4% of reported fires.

**Location.** About 21% of reported fires occur in the airway; 44% occur on the head, neck, or upper chest; 26% occur elsewhere on the patient; and 8% occur elsewhere in the patient (see the chart below).

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* Although many governmental bodies around the world require that surgical fires be reported to a competent authority (depending on the cause of the incident and the severity of the injury), many fires are not reported to any government office or regulatory agency. However, some of these fires—including those that occur in physicians, those with unclear reporting requirements, and those involving litigation—are identified to independent agencies such as insurers and ECRI, as well as (for U.S. facilities) the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and the National Fire Protection Association (NFPA).

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over the past 30 years have helped raise awareness of the risks, articles alone have not been enough, as preventable surgical fires continue to occur.

**Other Initiatives in the U.S.**

Also at a national level within the United States, the National Guideline Clearinghouse (NGC) accepted ECRI’s January 2003 Guidance Article “A Clinician’s Guide to Surgical Fires” as a national guideline. NGC, which was initiated by the Agency for Healthcare Research and Quality (AHRQ) at the U.S. Department of Health and Human Services, is a comprehensive database of evidence-based clinical practice guidelines and related documents. (For details, refer to the NGC Web site at www.guideline.gov.)

At the state level, Massachusetts and New York have promulgated patient safety initiatives for prevention of surgical fires. ECRI participated in those endeavors at the states’ request.

And within the U.S. armed forces, the Army Medical Command adopted a regulation in 2003 to provide policy and recommendations that will help ensure minimal risk of fires associated with the performance of surgical procedures in any health care setting to include, but not limited to, the following: operating room (OR), office-based, ambulatory surgery, and intensive care unit type (Department of the Army 2003).

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**References**


Joint Commission on Accreditation of Healthcare Organizations (JCAHO):


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**Has there been a surgical fire at your facility?**

*Register your response in this month’s Web poll*

- For the February Health Devices Web poll, we’re asking members to indicate whether any surgical fires (i.e., fires on or in the surgical patient) have occurred at their facility. Taking a few moments to answer this question will help you and your fellow members gain perspective on the incidence of this particular hazard.

To participate, simply log onto the members area of our Web site (www.ecri.org), access your membership home page, and register your vote in the poll. Responses will be tabulated through the end of February, and current results can be viewed at any time. ✺
A Team Approach to Surgical Fire Prevention

Understanding the Fire Triangle

A fire will occur when an *ignition source*, an *oxidizer*, and a *fuel* come together in the proper proportions and under the right conditions. These three basic elements of surgical fires—and all other types of fires—constitute the traditional fire triangle (see the image on this page). Keeping the elements of the fire triangle from coming together in ways that could lead to a fire requires that all team members be aware of the risks and that they consistently follow practices that can minimize those risks.

During surgery, these three elements are typically present in a number of forms, including surgical instruments, breathing gases, and associated equipment. Consequently, each member of the surgical team is associated with—and should be concerned with—one or more sides of the triangle:

- Surgeons are involved mainly with ignition sources, such as electrosurgical units (ESUs), lasers, electrocautery units, and fiberoptic light sources.
- Anesthesia providers are involved mainly with oxidizers, such as oxygen, nitrous oxide (N₂O), medical compressed air, and ambient air.
- Nurses are involved mainly with fuels, such as surgical drapes and prepping agents.

Of course, the above areas frequently overlap. For example, tracheal tubes, breathing circuits, and masks, which are all fuels, fall within the purview of anesthesia providers during surgery. Similarly, preps, drapes, and ointments applied by surgeons intraoperatively are also fuels, and nurses often handle ignition sources such as lasers and ESUs.

Each member of the surgical team should understand the various fire hazards presented by each side of the fire triangle and endeavor to keep the triangle’s elements apart. In addition, each team member should not only understand the basics of surgical fires, but also make a point of communicating information on the risks to the other team members—intraoperatively or in seminars, for example.

We discuss below each of the elements of the fire triangle—ignition sources, oxidizers, and fuels—as they relate to the surgical setting. For each element, we then describe steps that can be taken to manage or control that side of the fire triangle to minimize the risks of fire.

> **Poster available:** The preventive recommendations discussed in this section are summarized in the educational poster reproduced on page 54. A text-only version is available online through ECRI’s free-access clinical Web site, Medical Device Safety Reports (www.mdsr.ecri.org/static/surgical_fire_poster.pdf). In addition, large, full-color versions can be purchased from ECRI; contact ECRI’s Communications Department for details at +1 (610) 825-6000, ext. 5888, or at communications@ecri.org.

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**Controlling Ignition Sources**

**Ignition Sources in the OR**

Ignition sources provide the heat energy that can start a fire should the energy be directed onto or come in contact
with some fuel, either in ambient air or in an oxidizer-enriched atmosphere.

**Electrosurgery**

Electrosurgery is a widely used surgical technology that employs a high-frequency electric current passing through tissue to cut or cauterize that tissue. ESUs are the most common ignition source in surgical fires. By its very nature, electrosurgery can produce a high-temperature electric arc, incandescence at the probe tip, tissue embers ejected from the surgical site (“sputtering”), a flaring flame of organic gases from desiccated tissue, or combinations thereof, as seen in the photo on this page.

➤ **To learn more about the hazards:** See, for example, the following *Health Devices* articles:


**Surgical Lasers**

Surgical lasers are the second most frequently cited ignition source in surgical fires, but the fires they cause are often more serious because of the methods by which the energy is delivered and applied. Lasers use a collimated, coherent, monochromatic, directed, intense beam of electromagnetic radiation to cut, coagulate, or vaporize tissue. The wavelengths used include ultraviolet, visible, and infrared. The radiation is transmitted from the laser to the tissue through an array of mirrors, optical fibers, or waveguides. Delivered power is typically in the tens of watts but can be as high as 120 W in some lasers. However, the power density can be in the tens of thousands of W/cm² and can vary depending on the spot diameter. The spot diameter in turn can vary from a fraction of a millimeter to a few centimeters; it also varies with the distance from the laser aperture or focal point of the laser beam to the target tissue.

➢ **To learn more about the hazards:** See, for example, “Airway Fires: Reducing the Risk during Laser Surgery” in the April 1990 *Health Devices*.

**Electrocautery**

Electrocautery is the use of an electric current to heat a wire or scalpel blade to a high temperature. The hot wire or blade is used to cauterize tissue or vessels. In some cases, the electrocautery probe is also used to cut tissue. Unlike electrosurgery, electrocautery does not make the tissue part of the electric circuit, and no electrical arcs are generated.

Wire-type electrocautery probes have been involved in surgical fires. With these probes, wire temperatures are typically at or above incandescence (500°C [932°F]). Blade-style probes, in comparison, are more limited in their operating temperatures, and no incidents of surgical fires have been reported with their use.

➢ **Another facet of the hazard:** Some ignition sources can cause fires even when they are not in use. For example, there have been several reports of trash fires involving electrocautery pencils discarded contrary to the device’s instructions. Instructions typically call for measures such as breaking off the cauterizing wire and capping the device before discarding it. See, for example, the Hazard Report “Fire Caused by Improper Disposal of Electrocautery Units” in the March 1994 *Health Devices*.

**Fiberoptic Light Sources**

Fiberoptic light sources collect incandescent light energy and direct it into an optical fiber to illuminate specific areas during surgery. While often called “cold light,” these light sources can provide several hundred watts of visible, infrared, and ultraviolet light—enough energy to melt, scorch, or ignite materials. Although some of these wavelengths can be filtered out, this power is typically focused into a fiberoptic cable of small diameter, which can deliver a power density of up to several hundred W/cm².
Defibrillators

Defibrillators use electrical energy to stimulate a patient’s heart. Up to 360 J of electrical energy can be delivered through the paddles placed against the patient. If improper technique is used—for example, if the paddles are applied over a bony prominence or an electrocardiograph (ECG) lead, if the paddle pad is too small, if too little force is used, or if a high-impedance gel is mistakenly used—sparks can arc from the paddles to the patient. These sparks can serve as an ignition source, especially in an oxygen-enriched atmosphere or if vapors from an alcohol prepping solution are still present. With oxygen present at or near the location of paddle placement, sparks can, for instance, ignite body hair—including the fine sublayer of hair called vellus—which can then spread the fire to nearby fuels such as linens.

Although most defibrillator-ignited fires have occurred in emergency or critical care settings, emergency defibrillation may be needed on a surgical patient who is receiving supplemental oxygen through an open source on the

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To learn more about the hazards: See, for example, the following Health Devices articles:

- 2005 Sep: “Preventing Burns and Fires Caused by High-Powered Light Sources” (Hazard Report)
- 2004 Apr: “Endoscopic Light Sources and the Risk of Burns or Fire”
- 1995 Nov: “Fiberoptic Illumination Systems and the Risk of Burns or Fire during Endoscopic Procedures”

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**Terminology**

**Definitions of Terms Commonly Used When Discussing Surgical Fires**

- **Electrocautery.** Use of a conductor heated by an electric current to cauterize tissue.
- **Electrosurgery.** Use of an electric current passing through tissues to cut, cauterize, or desiccate tissue. In electrosurgery, unlike electrocautery, the patient is part of the electric circuit. See also electrocautery.
- **Free-end flame.** Flame emanating from an end of a tracheal tube or from a hole in the tube’s shaft. Fuel for this flame is derived from an intraluminal fire.
- **Fuel load.** The amount of burnable material involved in a fire. It is related to the amount of heat a fire can produce and thus the amount and severity of damage that can occur.
- **Intraluminal fire.** Flame within a tracheal tube.
- **Light.** Electromagnetic radiation typically including visible, ultraviolet, and infrared wavelengths emitted monochromatically (from lasers) or multichromatically (from a lightbulb or a fiberoptic light source).
- **OR fire.** Any fire that occurs in an operating room—not necessarily one that involves the patient. An example might be a circuit-board fire in an electrosurgical unit. See, in contrast, surgical fire.
- **Oxidizer-enriched atmosphere.** An atmosphere that enhances ignition and combustion because of the presence of oxygen (at or above atmospheric concentration), nitrous oxide (N₂O), or a combination of the two. The most commonly encountered type of oxidizer-enriched atmosphere is the oxygen-enriched atmosphere, in which the oxygen concentration exceeds 21% by volume or the oxygen partial pressure exceeds 21.3 kPa (160 torr, 3.1 psi).
- **Oxygen index.** Oxygen concentration at which a material will sustain a candle-like flame in an appropriate test apparatus.
- **Power density.** Rate at which light energy is delivered per unit area of irradiated surface. It is commonly expressed in W/cm².
- **Surface-fiber flame propagation.** A swiftly moving flame that spreads through fine nap fibers on the surface of a textile or through the hair on a patient’s skin. It occurs only in highly oxygen-enriched atmospheres (e.g., ≥50%); the effect of N₂O on surface-fiber flame propagation has not yet been studied.
- **Surgical fire.** Burning of materials on or in a surgical patient. Examples include electrosurgical ignition of surgical drapes or a tracheal tube and laser ignition of a bronchoscope inside the lungs.
face, or possibly when alcohol vapors are present on the body. As such, defibrillators are also considered a potential ignition source during surgery.

➤ To learn more about the hazards: See, for example, the Hazard Report “Using External Defibrillators in Oxygen-Enriched Atmospheres Can Cause Fires” in the December 2005 Health Devices.

Other Surgical Ignition Sources
Other ignition sources include argon beam coagulators and sparks from dental and orthopedic burs. They also include equipment failures in which an electrical component of a medical device fails, emitting smoke and sometimes flames; these are best handled by disconnecting the device from its electric power supply and removing the device from the room.

➤ To learn more about the hazards: See, for example, the Hazard Report “Sparking from and Ignition of Damaged Electrosurgical Electrode Cables” in the August 1998 Health Devices.

Minimizing Ignition Risks
Note: The applicability of the following recommendations must be considered individually for each patient.

During Electrosurgery
- Place the electrosurgical active electrode in a holster or another location off the patient when it is not in active use—that is, when it won’t be needed within the next few moments.
- Allow the electrosurgical active electrode to be activated only by the person wielding it.
- Activate the unit only when the active electrode tip is under the surgeon’s direct vision, especially if looking through a microscope or endoscope.
- Deactivate the unit before the active electrode tip leaves the surgical site.
- If open oxygen sources are employed, use bipolar electrosurgery whenever possible and clinically appropriate (such as for cauterization during head, neck, and upper-chest surgery). Bipolar electrosurgery creates little or no sparking or arcing and, to our knowledge, has not been involved in starting any surgical fires.
- Never use insulating sleeves cut from catheters or packing material and placed over electrosurgical active electrode tips; use only active electrode tips that are manufactured with insulation.
- Never use electrosurgery to enter the trachea.
- Never use electrosurgery in close proximity to flammable materials in oxidizer-enriched atmospheres.
- Disconnect contaminated electrosurgical active electrodes, and remove them from the surgical field.

During Laser Surgery
- Limit the laser output to the lowest clinically acceptable power density and pulse duration.
- Test-fire the laser onto a safe surface (such as a laser firebrick) before starting the surgical procedure to ensure that the aiming and therapeutic beams are properly aligned.
- Place the laser in standby mode whenever it is not in active use.
- Activate the laser only when the tip is under the surgeon’s direct vision.
- Allow the laser to be activated only by the person wielding it.
- Deactivate the laser and place it in standby mode before removing it from the surgical site.
- Use surgical devices designed to minimize laser reflectance.
- Never clamp laser fibers to drapes; clamping can break the fibers.
- When performing laser surgery through an endoscope, pass the laser fiber through the endoscope before introducing the scope into the patient. This will minimize the risk of damaging the fiber. Before inserting the scope in the patient, verify the fiber’s functionality.
- During lower-airway surgery, keep the laser fiber tip in view and make sure it is clear of the end of the bronchoscope or tracheal tube before laser emission.
- Use a laser backstop, if possible, to reduce the likelihood of tissue injury distal to the surgical site.
- Use appropriate laser-resistant tracheal tubes during upper-airway surgery. Follow the directions in the product literature and on the labels, which typically include information regarding the tube’s laser resistance, use of dyes in the cuff to indicate a puncture, use of a saline fill to prevent cuff ignition, and immediate replacement of the tube if the cuff becomes punctured.
Place wetted gauze or sponges adjacent to the tracheal tube cuff to protect the tube from laser damage, and keep them wet.

Wet any gauze or sponges used with uncuffed tracheal tubes to minimize leakage of gases into the oropharynx, and keep them wet.

Keep all moistened sponges, gauze, pledgets, and their strings moist throughout the procedure to render them ignition resistant.

Consider the use of towels soaked in saline or sterile water around the operative site to minimize the risk of igniting the towels. Note, however, that this should be done only if it will not compromise aseptic technique for that procedure.

**In General**

- If possible, stop supplemental oxygen at least one minute before beginning the use of electrosurgery, electrocautery, or laser surgery on the head, neck, or upper chest.
- Remove unneeded footswitches so they are not accidentally activated. (Do this only after the attached device has been placed in standby mode.)
- Dispose of electrocautery pencils properly—for example, break off the cauterizing wire and cap the pencil.
- Be aware that fiberoptic light sources can start fires. Complete all cable connections before activating the light source.
- Never place active fiberoptic cables on drapes or other flammable materials.

Place the fiberoptic light source in standby mode or turn the light source off when disconnecting cables.

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**Controlling Oxidizers**

### Oxidizers in the OR

Oxidizers are gases that can support combustion; examples include air, oxygen, and N₂O. Oxygen at concentrations above that of ambient air is often provided to patients by means of tracheal tubes, face masks, nasal canulas, or hyperbaric chambers. This can create oxidizer-enriched atmospheres—most often oxygen-enriched ones—which can enhance ignition and combustion.

### Oxygen-Enriched Atmospheres

Oxygen-enriched atmospheres are an often-unsuspected fire risk during surgery in the airway or on the head, neck, or upper chest. Such atmospheres are involved in the majority of reported surgical fires. They are defined as atmospheres in which the oxygen concentration exceeds 21% by volume or the partial oxygen pressure exceeds 21.3 kPa (160 torr, 3.1 psi).

Oxygen-enriched atmospheres lower the temperature and energy at which a fuel will ignite; as the oxygen concentration increases, so typically does the risk of fire. Many materials that will not burn or sustain a flame in ambient air will do so in oxygen-enriched environments. For instance, polyvinyl chloride (PVC) plastic, a component of tracheal tubes and many other medical devices, requires 26% oxygen to maintain burning. (See the photo on this page for an illustration of a tracheal tube fire.)

Also, fires involving oxygen-enriched atmospheres are hotter, more vigorous, and more intense than those in ambient air, and they spread more rapidly.

➢ To learn more about the hazards: Many of the *Health Devices* articles referenced above in the discussion of ignition sources include material on how the presence of an oxygen-enriched atmosphere contributes to the risk of a surgical fire. Additional discussion of this topic can be found in the ECRI Hazard Report “Fires from Oxygen Use during Head and Neck Surgery” in the April 1995 *Health Devices*.  

(continued on page 55)
Only You Can Prevent Surgical Fires
Surgical Team Communication Is Essential

The applicability of these recommendations must be considered individually for each patient.

At the start of surgery:
- Enriched O₂ and N₂O atmospheres can **vastly increase flammability** of drapes, plastics, and hair. Be aware of possible O₂ enrichment under the drapes near the surgical site and in the fenestration, especially during head/neck surgery.
- Do not drape the patient until all flammable preps have fully dried.
- Fiberoptic light sources can start fires: Complete all cable connections before activating the source. Place the source in standby mode when disconnecting cables.
- Moisten sponges to make them ignition resistant in oropharyngeal and pulmonary surgery.

For surgery with open delivery of supplemental O₂:
- Question the need for 100% O₂ for open delivery during head/neck surgery.
- As a general policy, use air or ≤30% O₂ for open delivery to the face.
- Arrange drapes to minimize O₂ buildup underneath.
- Keep fenestration towel edges as far from the incision as possible.
- Use an incise drape to isolate head and neck incisions from O₂ and alcohol vapors.
- Coat head hair and facial hair (e.g., eyebrows, beard, moustache) within the fenestration with water-soluble surgical lubricating jelly to make it nonflammable.
- For coagulation, use bipolar electrosurgery, not monopolar electrosurgery.

During oropharyngeal surgery:
- Scavenge deep within the oropharynx with separate suction to catch leaking O₂ and N₂O.
- Soak gauze or sponges used with uncuffed tracheal tubes to minimize gas leakage into the oropharynx, and keep them wet.

When performing electrosurgery, electrocautery, or laser surgery:
- Stop supplemental O₂ (if O₂ concentration is >30%) at least one minute before and during use of the unit, if possible.
- Activate the unit only when the active tip is in view (especially if looking through a microscope or endoscope).
- Deactivate the unit before the tip leaves the surgical site.
- Place electrosurgical electrodes in a holster or another location off the patient when not in active use (i.e., when not needed within the next few moments).
- Place lasers in standby mode when not in active use.
- Do not place rubber catheter sleeves over electrosurgical electrodes.


For more information, or to purchase full-color, glossy versions of this poster (11½ × 17½ in), contact ECRI:
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A NONPROFIT AGENCY
Nitrous Oxide
Nitrous oxide is an analgesic gas often mixed with oxygen and administered to surgical patients. It supports combustion by exothermally dissociating, thereby releasing heat and oxygen. Fires involving oxygen/N₂O mixtures (oxidizer-enriched atmospheres) can be as easily ignited and severe as fires involving 100% oxygen.

Medical Air
Medical air is air produced in the facility by compressing ambient air or by combining nitrogen and oxygen in the proper proportion. Under medical gas piping system pressures of 345 to 379 kPa (50 to 55 psi), medical air is oxygen enriched, in that the partial pressure of oxygen is 72 to 80 kPa (543 to 597 torr, 10.5 to 11.5 psi). However, medical air is not oxygen enriched at ambient pressure as it is delivered to the patient.

Ambient Air
Ambient air has about 21% oxygen, about 78% nitrogen, and fractional percentages of argon, carbon dioxide, and other gases. Ambient air can support the combustion of many potential fuels. And some materials are flammable in atmospheres of less than 21% oxygen. For example, the red rubber used in medical equipment will ignite and burn in just 17% oxygen.

Minimizing Oxidizer Risks
Note: The applicability of the following recommendations must be considered individually for each patient.

During Oropharyngeal Surgery
- Use suction deep within the oropharynx to scavenge the gases from the oropharynx of an intubated patient.
- Wet any gauze or sponges used with uncuffed tracheal tubes to minimize leakage of gases into the oropharynx, and keep them wet.
- Keep all moistened sponges, gauze, pledgets, and their strings moist throughout the procedure to render them ignition resistant.

In General
- Recognize that enriched oxygen and N₂O atmospheres can vastly increase flammability of drapes, plastic, and hair.
- Be aware of possible oxygen- and oxygen-/N₂O-enriched atmospheres near the surgical site under the drapes and in the fenestration, especially during head, neck, and upper-chest surgery.
- Question the need for 100% oxygen for open delivery to the face—for example, when using an oxygen mask or nasal cannula during head, neck, and upper-chest surgery. If possible, use air or oxygen levels at or below 30% for open delivery, consistent with patient needs.
- If possible, stop supplemental oxygen at least one minute before beginning the use of electrosurgery, electrocautery, or laser surgery on the head, neck, or upper chest.
- Use a pulse oximeter to monitor the patient’s blood oxygen saturation, and titrate the delivery of oxygen to the patient’s needs. Note that saturation readings fluctuate and are typically in the upper 90s, so the delivery of supplemental oxygen to maintain 100% saturation may not always be needed.
- Arrange drapes to minimize the buildup of oxygen and N₂O (such as from an uncuffed tracheal tube or a laryngeal mask airway) beneath the drapes.
- Use a properly applied incise drape, if possible, to help isolate head, neck, and upper-chest incisions from oxygen-enriched atmospheres and from flammable vapors beneath the drapes. Proper application of an incise drape ensures that there are no gas communication channels from the under-drape space to the surgical site.
- Dilute oxygen concentrations under drapes with medical air by placing a second cannula under the drapes near the face and providing a flow rate of at least 8 to 10 L/min.

Managing Fuels

Fuels in the OR
Fuels in the surgical setting encompass the following: most of the materials that come into contact with the patient or that are used on or in the patient, most of the...
materials that are in contact with or used by the surgical staff, and the patient’s body parts. While the amount of fuel may in some cases be small, the potential fire from such fuels can still be injurious or deadly.

Most of the fuels discussed below can ignite and burn in air, but all can easily ignite and burn in oxygen-enriched atmospheres. Also, the individual flammability characteristics of these fuels can be affected by interaction among the fuels. For example, alcohol can be absorbed into a towel, making the towel more flammable, or a fiberoptic light cable can penetrate a surgical drape and ignite underlying materials.

Common OR Materials
Common OR materials make up the largest fuel load in the OR—some items weigh several kilograms each. These common materials include the following:

- Operating table mattress, sheets, blankets, and pillows or foam headrests
- Patient gowns and straps
- Staff gowns, caps, gloves, and booties
- Towels, surgical drapes, incise drapes, bandages, dressings, and sponges

Many of these materials are composed of cellulose or polymeric fibers, such as rubber, nylon, polyethylene, and polypropylene. While fire retardants are used in some of these materials, they cannot be relied on to prevent surgical fires under all conditions. (And, notably, no surgical drapes are made with fire retardants.)

In oxygen concentrations above about 50%, the fine nap fibers on cotton surgical towels, drapes, and OR table linens can serve as a fuel that rapidly spreads a fire across the fabric surface throughout spaces of high oxygen concentration. This is a phenomenon known as surface-fiber flame propagation.

Alcohol and Other Volatile Organic Chemicals
Volatile organic chemicals include alcohol, acetone, and ether used in liquids such as skin preps, tinctures, degreasers, and some suture pack solutions and liquid wound dressings. These materials can be present during surgery in volumes from a few milliliters to about a liter.

Prepping agent fires are caused by the ignition of flammable vapors at the surgical site. Prep solutions can wick (or be absorbed) into hair and linens or can pool on or under the body. If the solutions are not allowed time to fully evaporate before draping, patient-warmed prep vapors can diffuse throughout the space beneath the drapes and rise out of the fenestration, presenting a fire hazard. Alcohol fires can be particularly difficult to detect because they burn with a flame that can be invisible under bright surgical lights.

To learn more about the hazards: See, for example, the following Health Devices articles:

- 2003 Nov: “Improper Use of Alcohol-Based Skin Preps Can Cause Surgical Fires” (Hazard Report)
- 1999 Jul: “Surgical Fire Hazards of Alcohol” (Talk to the Specialist)

Body Hair
Body hair of varying density and fineness is found on all people. As with the nap on cotton fabrics, body hair—especially vellus—can easily ignite and fuel a fire that rapidly spreads across the skin in areas of high oxygen concentration (e.g., above 50%). This is another example of surface-fiber flame propagation. In ambient air, on the other hand, vellus will shrivel from heat but will not propagate a fire. Similarly, other types of body hair do not tend to be easily ignited in ambient air during surgery.

Intestinal Gases
Intestinal gases are composed of varying concentrations of oxygen, nitrogen, carbon dioxide, hydrogen, and methane, a mixture that can vary widely in volume. In certain proportions, this mixture is flammable. Furthermore, during N₂O anesthesia, the gas can diffuse into the bowel and enrich the intestinal gas mixture, making it even more flammable.

Tracheal Tubes
Tracheal tubes weigh a few grams and are typically made from PVC, latex rubber, or silicone elastomer, all of which are flammable. Laser-resistant tracheal tubes often contain one or more of these materials; while they are resistant to certain laser wavelengths, these tubes may be flammable under other conditions—for example, if exposed to different laser wavelengths or to other heat sources such as an electrocautery pencil—or may have flammable parts, such as the cuff or inflation tube.

Combustion of a tracheal tube, as demonstrated in the photo on page 53, delivers flames, smoke, and hot gases into the airway and lungs. Tracheal tube fires typically
produce an intraluminal fire that generates fuel and heat to produce an extraluminal free-end flame.

Body Tissue

Body tissue is flammable if it has been fully desiccated by therapeutic heat, such as that from an ESU or laser at the small target area of their application. The organic materials that remain after desiccation can ignite and become incandescent embers or flares of gas.

Other Fuels

Other fuels include flexible bronchoscopes, face masks, breathing systems, petroleum jelly, adhesives, surgical instrument coverings and drapes, smoke evacuator hoses, blood pressure cuffs, and laser fiber sheaths.

Minimizing Fuel Risks

Note: The applicability of the following recommendations must be considered individually for each patient.

During Prep

■ Be aware that alcohol-based preps are flammable.
■ Avoid pooling or wicking of flammable liquid preps.
■ Allow flammable liquid preps to dry fully before draping; pooled or wicked liquid will take longer to dry than prep on the skin alone.
■ Keep fenestration towel edges as far from the incision as possible.

In General

■ Coat hair on the head and face (including eyebrows, beard, and mustache) within the fenestration with water-soluble surgical lubricating jelly to make the hair nonflammable.
■ Be aware of the flammability of tinctures, solutions, and dressings (such as benzoin, phenol, and collodion) used during surgery, and take steps to avoid igniting their vapors.
■ Moisten sponges to make them ignition resistant in oropharyngeal and pulmonary surgery.
When a Fire Occurs . . .
Knowing How to Respond in the Event of a Surgical Fire

Putting Out the Fire and Caring for the Patient

The initial response to a surgical fire should not be to retrieve a fire extinguisher or other fire-fighting equipment. Surgical fires can spread so rapidly that they will be out of control before an extinguisher can be used. In ECRI’s experience investigating and collecting reports on hundreds of surgical fires over the past 30 years, we are aware of only two or three cases in which an extinguisher was needed and used. An extinguisher should be employed only after other steps are taken, as described below. (The recommended actions for extinguishing a surgical fire—either on the patient or in the patient’s airway—are also summarized on page 60.)

For Small Fires
Small fires on the patient—such as those caused when a hot electrosurgical pencil ignites drapes on a patient, or when an electrocautery pencil ignites a blotting sponge—can be extinguished by patting out the fire with a gloved hand or towel, as shown in the photo on this page. If using a towel or sheet to smother the flames, pat out the fire in a direction away from your body.

For Large Fires
Large fires on or in the patient require a more comprehensive response:

- **Stop the flow of oxidizers to the patient.** In many fires, removing the oxidizer (oxygen and N₂O) sources—for example, by disconnecting the breathing circuit—will cause the fire to go out or at least lessen in intensity. Some materials burn only in oxygen-enriched atmospheres, and all materials burn more vigorously in them. Disconnection of the breathing circuit can also facilitate moving the patient rapidly (for example, to another OR).

- **Remove the burning materials from the patient, and extinguish them.** Removing the burning and burned materials is the only way to protect the patient from the heat of these materials. This applies regardless of whether the fire is burning on the patient or in the patient (as in the case of an airway fire). The heat can continue to cause thermal injury. Furthermore, should oxidizers be reintroduced to hot or molten materials, the fire may reignite. Also, removing these materials will allow clinicians to view all the areas of the patient that were near the fire, aiding their assessment of the injury. The burning materials should typically be removed by the surgeon and extinguished by another staff member.

**Care for the patient.** The patient must be cared for swiftly. He or she is probably not breathing, may be severely bleeding, and may still be in contact with other burning materials. The anesthesia staff should restore breathing with air (never oxygen) until all possible sources of fire, or of reignition, are suppressed. The surgeon should deal with the patient’s injuries. The nursing staff should extinguish any burning materials that are removed from, or that remain on, the patient.

There is some debate over the order in which the first two steps in this sequence should be carried out. We believe they should be performed simultaneously; others disagree. In any case, they should both be done as close to instantaneously as possible. In the fires that we have investigated, the instinctive actions of the surgical team members during a fire have resulted in these actions being performed simultaneously.

Note that there is no step specifying removal of the ignition source. In the vast majority of cases, this will not be
a consideration because the surgeon almost always has the ignition source in hand and will dispose of it to deal with the fire. Since the typical ignition sources for surgical fires deactivate when not in use, this step generally takes care of itself.

**For Airway Fires**

At the first sign of an airway or tracheal tube fire—whether during a tracheotomy or during internal tracheal/bronchial surgery—immediately and rapidly disconnect the breathing circuit from the tracheal tube and remove the tube. Have another team member extinguish it. Also, immediately remove cuff-protective devices and any segments of burned tube that may remain smoldering in the airway.

Care for the patient by reestablishing the airway, and resume ventilating with air until you are certain that nothing is left burning in the airway, then switch to 100% oxygen. Using oxygen before making certain that no burning or smoldering material is present will likely reignite the fire.

Examine the airway to determine the extent of damage, and treat the patient accordingly.

**About Other Fire-Fighting Alternatives**

**The use of aqueous solutions.** Aqueous solutions—such as bottled saline solution, bottled water, and tap water—can be used to help put out a fire (in combination with removal of the burning materials from the patient). Some hospitals keep a saline bottle, specially labeled “FOR FIRE,” on the back table just for this purpose. Recognize, however, that surgical drapes are waterproof, and applied water may not penetrate to underlying burning materials.

While basins of water or saline are also sometimes used to extinguish surgical fires, bottled solutions should be the preferred extinguishing agent. This is because some basins (e.g., suture catch basins) may contain flammable liquids, such as alcohol. If used by mistake, these liquids would explosively increase a fire.

**The use of fire extinguishers.** Although they should not be the first choice when dealing with a surgical fire, fire extinguishers may be needed in the extremely rare instance in which a fire engulfs the patient or has migrated off the patient or involves other materials in the OR. Surgical staff should know why, when, and how to use fire extinguishers and other materials that can be used to put out a fire.

ECRI recommends carbon dioxide (CO₂) extinguishers for use in the OR. Specifically, we recommend that a 5 lb CO₂ extinguisher be mounted just inside the entrance of each OR in the hospital. In addition, we recommend that a 20 lb dry-powder fire extinguisher be available outside the OR, but within the OR suite, for use as a last resort for fighting catastrophic fires. See the Talk to the Specialist article on page 62 for additional discussion.

**Not appropriate! The use of fire blankets.** Fire blankets—typically wool blankets that are treated with fire retardants and are placed over a fire to smother it—should never be located in an OR and should never be used for surgical patient fires. Such blankets could trap the fire next to or under the patient or could displace surgical instruments, leading to further injury. In addition, for cases in which a fire is sustained by oxygen delivered to the patient, a fire blanket would be ineffective at extinguishing the fire; in fact, the blanket itself could burn if it is used in an oxygen-enriched atmosphere.

For additional information, refer to the Talk to the Specialist article “Fire Blankets in the OR?” on page 63. Although fire blankets have a valid place in many industrial settings, they are not appropriate for use in the unique environment of a hospital OR.

**If Evacuation Is Necessary . . .**

In rare cases, extreme smoke and fire conditions may force the evacuation of the specific OR in which the fire occurs. ECRI is aware of only one case in the past 35 years in which the surgical team had to evacuate the OR and temporarily leave the burning patient behind. We are not aware of any incident in which the entire OR suite needed to be evacuated. Nonetheless, we present the following guidance for OR evacuation.

When evacuation is necessary, the acronym RACE defines the actions that should take place: Rescue, Alert, Confine, and Evacuate.

**Rescue.** Reasonable attempts to rescue the surgical patient from the fire and the OR should be made. Several rescuers will likely be needed to deal with disconnecting the patient from any devices (such as an anesthesia machine or electrosurgical unit) and, possibly, to move the operating table. The rescuers should not place themselves at severe risk, though each individual will have to decide what level of risk he or she considers to be severe.

**Alert.** The staff in nearby ORs should be alerted to the fire and kept informed in case they need to evacuate their

(continued on page 61)
Emergency Procedure

Extinguishing a Surgical Fire

Fighting Fires ON the Surgical Patient

Review before every surgical procedure.

Small fire. In the event of a small fire on the patient, immediately
Pat out or smother the fire, or remove the burning material from the patient.

Large fire. In the event of a large fire on the patient, immediately

1. Stop the flow of breathing gases to the patient.
2. Remove the burning material from the patient, and have another team member extinguish it. If needed, use a CO₂ fire extinguisher to put out a fire on the patient.
3. Care for the patient:
   — Resume patient ventilation.
   — Control bleeding.
   — Evacuate the patient if the room is dangerous from smoke or fire.
   — Examine the patient for injuries and treat accordingly.
4. If the fire is not quickly controlled:
   — Notify other operating room staff and the fire department that a fire has occurred.
   — Isolate the room to contain smoke and fire.

Save involved materials and devices for later investigation.

Extinguishing Airway Fires

Review before every surgical intubation.

At the first sign of an airway or tracheal tube fire, immediately and rapidly

1. Disconnect the breathing circuit from the tracheal tube.
2. Remove the tracheal tube, and have another team member extinguish it. Remove cuff-protective devices and any segments of burned tube that may remain smoldering in the airway.
3. Care for the patient:
   — Reestablish the airway, and resume ventilating with air until you are certain that nothing is left burning in the airway, then switch to 100% oxygen.
   — Examine the airway to determine the extent of damage, and treat the patient accordingly.

Save involved materials and devices for later investigation.


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patients from the area. In addition, fire alarm systems should be activated. Often, these systems call assistance from within the facility to the area of the alert; some systems also call the local fire department.

**Confine.** The smoke and fire should be contained in the OR by closing all the doors. The medical gas zone (shut-off) valves for the affected OR should be shut to prevent piped gas and vacuum systems from sustaining the fire. Many facilities have automatic dampers in the air-conditioning ducts to prevent smoke migration. Some facilities have central smoke evacuator systems that are similar to vacuum systems; these should also be shut off. In addition, electric power to the involved OR should be turned off at the circuit-breaker panel; this will prevent it from sustaining electrical fires and will prevent an electric shock hazard for firefighters who are using water from extinguishers or hoses.

**Evacuate.** The incident OR—and, if necessary, the surgical suite (though this is very unlikely)—should be evacuated in an orderly manner to preplanned areas capable of handling the needs of the surgical patients.

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**Conducting Fire Drills to Practice and Refine Your Fire Response Plan**

Quick and effective response to a surgical fire—or any other fire that occurs in the operating room (OR) or OR suite—requires a combination of planning and practice. A fire response plan provides a detailed description of who will do what in the emergency (Flowers 2004). A thorough plan will account for the various kinds of OR fires that can occur—from the small, quickly extinguished fire with no injury to the large, smoky, and potentially catastrophic fire requiring evacuation of the OR or possibly the whole OR suite.

For fire safety initiatives, practice usually takes the form of fire drills. After staff are educated about the fire response plan, drills should be conducted to help staff learn the plan and also to help the facility test the effectiveness of the plan and identify areas for improvement. When planning a fire drill, be sure to consider the following elements:

- The proper response of each surgical team member and the OR suite staff. For example, the surgeon should remove the burning material, the anesthesia provider should disconnect the breathing circuit, nursing personnel should extinguish the burning material and alert suite staff, and the suite staff should provide assistance as needed.

- When, how, and what to communicate within the OR, within the OR suite, with the rest of the facility, and with the local authorities (e.g., fire department, state department of health).

- How the patient can easily and safely be moved, if needed, to another OR or to another safe area.

- How the spread of smoke should be prevented—for example, by closing doors or using smoke doors and air duct dampers.

- The location and operation of fire extinguishers, fire alarm pull stations, and exits.

- The location, operation, and coverage area of medical gas zone (shutoff) valves.

- The location, operation, and coverage area of electrical supply panels.

- What the response of additional fire-fighting personnel (such as the fire response team and local fire department) should be.

After completing the drill, be sure to follow up with a review to learn how to improve the fire response plan and thus improve OR safety.

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**Further Reading**


Salmon L. Fire in the OR; prevention and preparedness [home study program]. *AORN J* 2004 Jul;80(1):42-60.
QUESTION
What type of fire extinguisher should we have in our operating rooms (ORs)?

ANSWER
ECRI prefers carbon dioxide (CO₂) extinguishers for use in the OR, for the reasons outlined below. We recommend that a 5 lb CO₂ extinguisher be mounted just inside the entrance of each OR in the hospital.

**Recommended: CO₂ extinguishers.** CO₂ extinguishers expel a fog of cold CO₂ gas and snow that leaves no residue as it smothers and cools a fire. The cold fog is unlikely to injure the burning patient (or staff member) and in fact may help minimize thermal injury. The range of these extinguishers is only a few meters.

CO₂ extinguishers are Class BC extinguishers, meaning they are rated for use on flammable liquid and electrical fires (see the inset). However, ECRI’s testing shows that CO₂ extinguishers are also very capable of fighting small Class A fires—that is, fires involving common OR combustibles, such as gowns and blankets.

CO₂ extinguishers are made in many sizes, with the 5 lb, 10 lb, and 20 lb models being the most widely used. ECRI recommends the 5 lb model for placement in the OR for rapid use in case of a surgical fire.

**Only as a last resort: dry-powder extinguishers.** Dry-powder extinguishers use a charge of CO₂ that propels a powder to a distance of up to about 5 m (16.5 ft) to cool and smother the fire. The powder is usually monoammonium phosphate; it is mixed with metallic stearates, tricalcium phosphate, or silicone to improve its storage, flow, and water-repellency characteristics. Dry-powder extinguishers are Class ABC extinguishers. They are made in many sizes, with the most widely used being the 2 lb, 5 lb, 10 lb, and 20 lb sizes.

Dry-powder extinguishers are considered a last resort in surgical fires for several reasons: The very fine powder cannot mix with water and is therefore difficult to remove from a wound. The powder is also an airway and mucous membrane irritant that could interfere with staff or rescuer breathing and with visibility in the room (because of the dusty cloud it produces). Further, the extinguisher will contaminate the entire OR when discharged because the powder is very fine and widely dispersed.

Nevertheless, ECRI recommends that the OR suite (not each room) be equipped with a 20 lb dry-powder fire extinguisher for use in last-ditch rescue and extinguishing efforts—that is, in cases for which the OR fire extinguisher is insufficient.

**Not recommended.** ECRI recommends against using the following types of fire extinguishers in the OR:

- **Water-based fire extinguishers** use water, sometimes mixed with wetting or antifreeze agents, and a source of pressure to propel the water through a nozzle. A concern with these extinguishers is that the water they use is not sterile and could cause a patient infection or a toxic reaction.

  Pressurized water extinguishers are typically Class A, contain 20 L (5 gal) of water, and expel a water stream from a nozzle to a distance of up to 7 m (23 ft). For surgical fires, the stream should be

(continued on page 63)
made into a spray by placing a thumb over the nozzle’s opening; the spray will cool and smother a larger area of the fire than the stream. Using one of these extinguishers could result in an electric shock to the user because the water may be electrically conductive. ECRI does not recommend the use of water-based extinguishers in the OR.

- **Water-mist fire extinguishers** expel a mist stream, usually to a distance of up to 3 to 4 m (10 to 13 ft), to cool and smother a fire. They are typically rated Class AC and contain 10 L (2.5 gal) of distilled water. Although water-mist extinguishers are intended for use on Class A fires in the vicinity of electrically energized devices and will not conduct electricity back to the user, water that has pooled in, on, or around electrically energized devices could cause an electric shock. In addition, the water used in these extinguishers is not sterile. ECRI does not recommend the use of water-mist fire extinguishers in the OR.

- **Halon-replacement fire extinguishers**—such as FE-36, FM-200, and Halotron—can be effective at putting out fires, but they can be expensive and problematic to place and use. Most of these extinguishers are rated Class ABC.

Many halon-replacement extinguishers use halogenated hydrocarbons that cool and smother the fire. In very hot fires, these agents break down to form toxic pyrolysis products, mostly acid gases and halogens. Also, many of these agents can cause cardiac arrhythmias if ingested or inhaled. The effects of these agents when discharged onto a patient wound are not defined and may cause health problems (e.g., emboli). ECRI does not recommend the use of halon-replacement fire extinguishers in the OR.

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**Talk to the Specialist**

*Fire Blankets in the OR?*

**Question.** Are fire blankets appropriate for use in the operating room (OR)?

**Answer.** No. Fire blankets—typically wool blankets that are treated with fire retardants and are placed over a fire to smother it—should never be located in an OR and should never be used for surgical patient fires. There are several reasons:

- The fire could be sustained by oxygen delivered to the patient, preventing the blanket from being effective.
- A fire blanket will trap the fire next to and under the patient, causing further injury.
- Placing a fire blanket on a patient may displace instruments and cause further injury.
- Fire blankets will burn if used in oxygen-enriched atmospheres and are therefore not effective against fires in such atmospheres.

- If a fire blanket is located in an OR, staff may assume it’s suitable for a surgical fire, placing the patient at further risk.
- Given the suddenness and intensity of most surgical fires, there is insufficient time to get a fire blanket, unpack it, and apply it to the patient before serious or fatal injuries are sustained.

Fire blankets have a valid place in many industrial settings, but not in the unique environment of a hospital OR. For more details on this subject, see the earlier version of this Talk to the Specialist article in the November 1999 *Health Devices*.

**UMDNS term.** Blankets, Fire [16-477]

**Suppliers.** These products are available from a variety of sources; consult ECRI’s *Health Devices Sourcebook* or Health Devices International Sourcebase for suppliers.
Selected Bibliography

A full bibliography is available through the members area of ECRI’s Web site, www.ecri.org. To access this document: Log onto your membership home page, and select the “Health Devices Journal” option; a link to the bibliography is included with the contents list for the February 2006 Health Devices.

Standards and Guidelines

Association of Operating Room Nurses (AORN):
Joint Commission on Accreditation of Healthcare Organizations:
National Fire Protection Association (NFPA):

Literature Citations

Published by ECRI or ECRI Staff

ECRI (in Health Devices)
A clinician’s guide to surgical fires: how they occur, how to prevent them, how to put them out [guidance article]. Health Devices 2003 Jan;32(1):5-24.
Fires during surgery of the head and neck area:
OR fires don’t need flammable anesthetics [poster]:
Health Devices 1982 May;11(7):207.
Health Devices 1994 Apr;24(4):156.
Preventing burns and fires caused by high-powered light sources [hazard report]. Health Devices 2005 Sep;34(9):325-6.
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Bruley ME:
Frequent questions on OR fire safety. OR Manager 2003 Dec;19(12):17-8.
Surgical fires: perioperative communication is essential to prevent this rare but devastating complication. *Qual Saf Health Care* 2004 Dec;13(6):467-71.


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Salmon L. Fire in the OR; prevention and preparedness [home study program]. *AORN J* 2004 Jul;80(1):42-60.


Arrhythmia Analysis Q&A


Summary. Real-time electronic analysis of an electrocardiogram (ECG) waveform during continuous physiologic monitoring allows detection of cardiac arrhythmias, which enables clinicians to be audibly alerted to the presence of these abnormal heart rhythms. Like most other clinical alarm systems, devices that perform arrhythmia analysis require clinician vigilance in order to be properly applied in patient care. The arrhythmia algorithms used by today’s cardiac monitors are not perfect, and a thorough understanding of their capabilities and limitations is vital to safe and effective use. This article answers some basic questions about arrhythmia analysis as it applies to continuous cardiac monitoring.

Q. What is arrhythmia analysis?
Arrhythmia analysis is a function performed by cardiac monitors to electronically examine a patient’s electrocardiogram (ECG) waveform and detect any arrhythmias (i.e., abnormal heart rhythms). The main purpose of arrhythmia analysis in physiologic monitoring is to trigger alarms that notify staff members of clinically significant changes in a patient’s cardiac condition, some of which may be immediately life threatening.

Q. How does arrhythmia analysis work?
Although the arrhythmia analysis methods employed by various monitor suppliers may differ slightly, most operate similarly on a fundamental level, using the following three-step procedure:

1. **Beat detection** is the process by which a monitor distinguishes beats (i.e., QRS complexes) from P waves, T waves, signal artifact, and other electrical activity in an ECG rhythm. (See the diagram on page 68 for a depiction of the parts of an ECG.) Once beats are detected, a count of the detected beats per minute determines the heart rate, and the beats are ready to be classified.

2. **Beat classification** is the process by which a monitor compares each detected beat with previous beats—and, in some circumstances, with other beat classification criteria—to determine, at minimum, whether each beat is “normal” or ventricular.* Many products classify beats by storing families of previous, similar beats as templates that describe waveform characteristics such as QRS height, width, and timing. Subsequent beats can then be classified by comparing them to these templates.

Classification relies heavily on a learning process that starts when a patient is first connected to a monitor. To perform this process, the monitor searches for dominant beats, which are recurring QRS complex...

* Most monitoring systems are designed to determine only whether a beat originates outside the ventricles or in them. These systems classify as “normal” any beats originating outside the ventricles, regardless of their location. They do not analyze P waves, which would be necessary to determine the exact origin (e.g., the sinusoidal [SA] node, the atrioventricular [AV] node) of each nonventricular beat.
shapes that a monitor considers normal, and then creates corresponding templates. Although beat classifications vary among monitor suppliers, most algorithms distinguish between normal and ventricular beats: normal beats match the beat template(s) created during the learning process; ventricular beats fail to match them, in addition to meeting other criteria for ventricular beats (e.g., wide QRS). (During the beat classification process, most algorithms can also identify paced beats, which are initiated by an artificial pacemaker. Paced beat detection and analysis are outside the scope of this article.)

After the initial learning process, a clinician can manually initiate a relearn as needed to reflect any changes in a patient’s rhythm. Some monitors automatically relearn under certain circumstances, such as when an ECG electrode is reconnected following a leads-off condition or when the ECG lead being displayed (e.g., lead I, II, III) is changed.

During the learning process, many monitors can misinterpret ventricular beats as normal QRS complexes, which can diminish the algorithm’s ability to correctly classify subsequent ventricular beats and detect arrhythmias. Consequently, clinicians must ensure that learning occurs during a predominantly normal, nonventricular rhythm. Such verification should be done in any of the following circumstances:

- When a patient is first placed on the monitor
- Following a manually initiated relearn
- When performing tasks that trigger automatic relearning (as discussed above)

As a routine precaution, clinicians should also periodically verify that the patient’s beats appear normal.

Over time, alterations in a patient’s underlying rhythm can produce QRS shapes that differ from stored beat templates, sometimes causing false alarms. Although many of today’s algorithms use adaptive templates that are refined and adjusted in response to these changes, the problem can still occur. Recurring false alarms can often be eliminated by manually initiating a relearn.

3. **Rhythm analysis** is the process of comparing a sequence of classified beats against stored definitions of what qualifies as an arrhythmia. (Some examples of this analysis are depicted in the table on page 69.) The criteria used for arrhythmia identification vary among algorithms, and in some cases are user adjustable.

Two particular arrhythmias—asystole and ventricular fibrillation (v-fib)—are detected somewhat separately from this three-step procedure. Systems identify asystole when the beat detection process does not detect any QRS complexes for a specified duration (e.g., five seconds). V-fib detection generally occurs in parallel with the other arrhythmia analysis processes and relies on a dedicated algorithm that monitors the ECG rhythm for particular frequency components that indicate fibrillation.

Q. What are the limitations of arrhythmia analysis?

Proper use can improve the effectiveness of arrhythmia analysis, but there are limitations inherent in the current technology. Some of these limitations are:

**Typically Not Designed to Detect Atrial Arrhythmias**

As noted above, most monitoring systems are designed to determine only whether a beat originates in the ventricles or not in the ventricles; this means that some or all atrial arrhythmias will not trigger an alarm and will not be flagged as arrhythmias in stored review logs. Aside from offering the ability to review stored ECG waveform data, these systems are not viable tools for diagnosing and monitoring atrial arrhythmias. Although detecting atrial arrhythmias is typically unnecessary for identifying conditions that are immediately life threatening, it can be useful for diagnosing potential future problems and for documenting a patient’s cardiac activity.

ECRI is aware of just one vendor currently offering a monitor that directly assesses atrial events, which can be done only by analyzing P waves. Some other vendors offer products that detect certain atrial events indirectly by examining ventricular activity; for example, atrial fibrillation
can be detected by looking for variations in the interval between QRS complexes, which are ventricular phenomena.

**Interference from Signal Artifact**

Signal artifact is electrical activity in an ECG waveform caused not by heartbeats, but by circumstances such as patient movement or poor electrode contact. These circumstances can create electrical activity that masquerades as QRS complexes or prevents a monitor from detecting true QRS complexes; both of these effects can create false alarms or mask true alarm conditions. Such problems can often be addressed by reapplying or repositioning electrodes.

**Low Signal Amplitude**

One of the primary ways that beat detection processes attempt to differentiate QRS complexes from other electrical activity (e.g., P waves, T waves, electrical noise) is by looking for tall peaks that are above a certain detection threshold and therefore may be R waves. If low ECG signal amplitude causes R-wave peaks to fall below the algorithm’s detection threshold, the monitor may not be able to detect beats, thereby producing false alarms for asystole.

Low signal amplitude is sometimes caused by poor skin preparation or dried electrode gel and thus can sometimes be remedied by addressing these issues. Additionally, clinicians should ensure that monitors are configured to analyze the lead(s) that show the largest amplitude and cleanest signal. Ideally, R-wave amplitude should exceed 0.5 mV, although some monitors may be capable of detecting R waves down to 0.15 mV. To measure amplitude, clinicians can compare R waves to a 1 mV calibration pulse (if available) on the monitor display or strip-chart recording. Note that adjusting the gain, which clinicians do to increase the size of a waveform on a display, does not affect the amplitude of the analyzed signal and therefore is not a solution to false alarms caused by low signal amplitude.

**Misidentification of Tall P and T Waves**

The amplitude of R waves is significantly larger than that of P and T waves for most patients, so wave amplitude is used as a beat detection criterion. In addition, some arrhythmia algorithms also use the expected time between beats to help distinguish R waves from other tall waves. Even with these approaches, some patient rhythms may contain large P or T waves that can be mistaken for R waves or ventricular beats (e.g., premature ventricular contractions, or PVCs). This problem can sometimes be resolved by analyzing a different ECG lead.


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**Sample Rhythm Analysis**

<table>
<thead>
<tr>
<th>This sequence of classified beats...</th>
<th>Indicates this arrhythmia</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Ventricular couplet" /></td>
<td>Ventricular couplet</td>
</tr>
<tr>
<td><img src="image2.png" alt="Ventricular bigeminy" /></td>
<td>Ventricular bigeminy</td>
</tr>
<tr>
<td><img src="image3.png" alt="Ventricular tachycardia (v-tach)*" /></td>
<td>Ventricular tachycardia (v-tach)*</td>
</tr>
</tbody>
</table>

*The number and rate of consecutive ventricular beats needed to qualify as v-tach varies based on user- or manufacturer-specified thresholds.*
Q. Should the arrhythmia algorithm a supplier uses be a significant factor to consider when purchasing a monitoring system?

No. Although each monitor vendor uses its own propriety arrhythmia analysis algorithm, ECRI does not believe that any current differences in these algorithms are significant enough to play a major role in purchasing decisions. While one arrhythmia algorithm may appear to perform better than another on a particular rhythm, it may not perform as well on a different rhythm or different patient. Even algorithms shown to be highly accurate when tested against recorded arrhythmia tapes will not properly detect all arrhythmias for all patients and will occasionally issue false alarms. There are no arrhythmia algorithms that operate with 100% sensitivity and specificity. ECRI is not aware of any evidence that one supplier’s algorithm is clinically superior to another overall.

Before they are released, devices are generally tested against available waveform databases. (This is done in part to achieve marketing clearance from the U.S. Food and Drug Administration [FDA], as described in the American National Standards Institute/Association for the Advancement of Medical Instrumentation EC57:1998 standard, “Testing and Reporting Performance Results of Cardiac Rhythm and ST Segment Measurement Algorithms.”) Results of specificity and sensitivity testing for a device’s ability to discriminate between normal and ventricular beats may be available from some suppliers. However, ECRI sees many shortcomings to database testing and therefore does not recommend using these results as a major purchasing consideration. These shortcomings include:

- Algorithms alone do not necessarily determine overall clinical performance. Alarm system design and arrhythmia documentation and trending may be equally important. (ECRI favors flexible arrhythmia systems that can be easily tailored to an individual patient’s needs—e.g., systems that allow configurable beat and rate thresholds for v-tach alarms.)

- Results obtained from a system may vary each time that a record is run. For totally reproducible results, the algorithms would require the same starting conditions.

- Sensitivity and specificity percentages can be misleading because they represent averages for all tested patients. These figures do not describe problems algorithms might have had in detecting ventricular beats on particular people. For example, consider a hypothetical algorithm tested on three patients:

  - For patient A, the algorithm correctly identified all 95 ventricular beats as “ventricular.”

  - For patient B, the algorithm incorrectly identified all three ventricular beats as “normal.”

  - For patient C, the algorithm incorrectly identified both ventricular beats as “normal.”

Although this equates to 95% sensitivity, which would typically be regarded as good performance, this algorithm actually performed poorly by failing to identify ventricular complexes for two of the three patients.

(For more information about the limitations of waveform database testing, please refer to the Evaluation of ambulatory telemetry arrhythmia monitoring systems in the July 1994 Health Devices.)

Q. Can the number of false arrhythmia alarms be reduced?

Yes, there are steps you can take to reduce the number of false alarms. Due to the limitations of electronic arrhythmia analysis, however, the potential for nuisance alarms will always exist.

As discussed above, many false alarms result from low signal amplitude, electrical noise, and signal artifact caused by poor skin preparation, poor electrode contact, or ineffective electrode positioning. Correct electrode application can often reduce the incidence of false alarms.

Additionally, although most monitors prevent users from disabling critical arrhythmia alarms (e.g., v-fib, asystole), they generally allow some adjustments to be made to the algorithm. For example, many systems let clinicians define the number and rate of consecutive ventricular beats needed to initiate a v-tach alarm. In addition, it is often possible to adjust alarm parameters, such as the alarm priority (e.g., low, medium, high) for nonlethal arrhythmias, or to disable certain arrhythmia alarms individually. This can be useful for patients who regularly exhibit a nonlethal arrhythmia such as ventricular bigeminy; if clinicians are aware of such an issue and determine that notification of each occurrence is unnecessary, the bigeminy alarm can be disabled or limited to a visual alert. Doing so would limit unnecessary alarm noise while keeping alarms for other arrhythmia conditions active.
ECRI Problem Reporting System

Problem Reports

Policy statement. ECRI encourages members, healthcare providers, patients, and suppliers to report all medical-device-related incidents and deficiencies to us so that we can determine whether a report reflects a random failure or one that is likely to recur and cause harm. Reports can be generic or model specific. We add all reports to our internal confidential databases to track trends of device failure or lot-specific defects. Although many reports do not result in a published article, we inform the reporting party of our findings or opinions when appropriate. As soon as we become aware of device hazards and problems, we inform the suppliers and invite them to respond constructively.

If our investigations yield information that should be communicated to the healthcare community, we publish the information in Health Devices as either a Hazard Report or a User Experience Network™ (UEN™) article, depending on the level of risk associated with the problem. Member hospitals may reproduce these reports for internal distribution only. This policy does not apply to other articles in Health Devices, unless otherwise noted.

Submitting a report. Please report problems to us by mailing or faxing one of the problem reporting forms in your Health Devices binder, by sending us a letter, by completing the online form available at www.ecri.org/problemreport, or by calling +1 (610) 825-6000. The identity of the reporting individual or institution is never revealed without permission.

Hazard Report

Broken Chest Supports on OSI Spinal Tables Cause Patients to Unexpectedly Shift Position during Procedures

PROBLEM
Two member hospitals report that the chest supports on their Orthopedic Systems Inc. (OSI) Jackson Spinal Tables (Models 5890 and 5892, respectively) broke during clinical procedures, causing the patients’ positions to shift unexpectedly. No one was hurt in either incident. However, spinal surgery patients are especially vulnerable and fragile, so unexpected movement could cause severe injury, including paralysis, especially if it were to happen during surgery.

Following the failure of one of its tables, one of the hospitals inspected its other Jackson Spinal Tables, which were only a year old, and discovered cracks on the tables’ chest supports.

DISCUSSION
Jackson Spinal Tables enable clinicians to position, support, and secure patients during spinal surgery. The chest supports bear some of the patient’s weight; cracks in these supports could lead to a break, causing a patient’s position to unexpectedly shift.

OSI says that many users follow an improper procedure for removing the chest supports from the table frame, which can lead to damage. The chest support is attached to the frame by four Velcro straps. According to the vendor, some users detach only two of the four Velcro straps and then try to laterally pry off the chest support. Manipulating the chest support this way can unduly stress the support and may lead to cracking.
The correct procedure entails removing all four straps and then levering the chest support head to foot until it is detached.

OSI says that it does not plan any corrective action at this time. One of the affected hospitals said that when it received replacements for the damaged parts, the new chest supports were visibly thicker than the originals. However, OSI said that there had been no design change; instead, it attributed any differences to the normal variation in the thickness of the plastic that is used to manufacture the part.

ECRI was unable to determine whether the cracked chest supports were the result of user error or an inadequately designed part, but the problem—whatever its cause—may affect other facilities. We encourage OSI to monitor reports of such incidents and to ensure that its training materials specifically call attention to proper setup and removal of the chest supports. If incidents of cracked chest supports on Jackson Spinal Tables become more frequent, we encourage OSI to make these components more robust.

**RECOMMENDATIONS**

Immediately inspect the chest supports on all OSI Jackson Spinal Tables. If any cracks are found:

1. Remove the device from service and notify the supplier and ECRI. Obtain and install replacement supports (Part No. 5840-580) before returning the table to service.

2. Update your procedures to require clinical engineering personnel to inspect the devices at least quarterly and to require clinical users to inspect the chest supports before each use. These procedures should include a visual inspection for cracks. If any cracks are found, follow the procedure described in Recommendation 1.

3. Obtain the vendor’s training materials and perform retraining sessions for users, emphasizing the correct setup and removal of the chest supports as described in the user guide.

**UMDNS term.** Tables, Operating, Spinal [18-376]

**Supplier.** Orthopedic Systems Inc. [101580], Union City, California (USA); +1 (800) 777-4674, (510) 429-1500; www.osiosi.com

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**ECRI’s Hazard Reports**

A Hazard Report describes a possible source of peril, danger, or difficulty. We publish reports about those units in which we have identified a fault or design feature that might, under certain circumstances, place patients or users at risk. These reports describe the problem and ECRI’s recommendations on how to correct or avoid it. Publication of a report on a specific brand name and model of device in no way implies that competitive devices lack hazardous characteristics.

When deciding whether to discontinue using a device that ECRI believes poses a risk, staff should balance the needs of individual patients, the clinical priorities, and the availability of safer or superior products against the information we provide. Clinical judgment is more significant than an administrative, engineering, or liability decision. Users can often take precautions to reduce the possibility of injury while waiting for equipment to be modified or replaced.
User Experience Network

Overheating Can Damage Power Supplies, Switches, and Cords on Fresenius 2008H and 2008K Hemodialysis Units

HOSPITAL
After smoke was seen coming from our Fresenius 2008K hemodialysis unit, we found melted insulation and overheated wires inside the device’s power supply. The problem’s cause couldn’t be identified. Our biomedical engineers later discovered a Fresenius service bulletin published in July 2002 (available on the Web at www.fmcna.com/fusa/fieldbulletins/02fhk001.pdf) that recommended inspecting the power switch and cord on all 2008H and 2008K units. After reading this bulletin, we obtained replacement cords from Fresenius and have not experienced the problem since.

ECRI
Health Devices first described the overheating problem in a January 2003 article about the failure of a Fresenius 2008H hemodialysis unit. That report did not address the potential for similar problems with the 2008K.

It isn’t certain whether replacing the power cords will fix the problem. However, the experience of the reporting hospital suggests that the power cord should at least be suspected as the cause if the overheating problem occurs.

The reporting hospital noticed that the replacement power cords received from Fresenius appear to be different from those originally provided with the 2008H and 2008K. Specifically, the replacement cords have a label that was not present on the original cords (see the photo on this page). This raises the question of whether Fresenius is supplying different power cords as a way to address the overheating.

Fresenius has declined to confirm whether the cords are new models designed to fix the problem. If the company has identified a solution, it should publicize this information. Not providing such guidance, if available, places an unreasonable burden on equipment owners. We also believe that Fresenius should notify all users of the problem and, as applicable, provide the replacement parts and service free of charge. If Fresenius does not know of a solution, we recommend that it develop one as soon as possible.

We do not believe this problem presents a safety hazard to patients or staff members. Although we have not had the opportunity to examine the 2008H or 2008K units, our experience indicates that there is little risk of electrical fire associated with this type of problem: Even if the equipment fails during a dialysis procedure, the patient will not be in immediate danger. However, the patient will be forced to wait until another machine becomes available. The patient will then be transferred to that machine, which is a cumbersome process; in some cases, it may even be necessary to reschedule the dialysis session.

RECOMMENDATIONS
Note that performing inspections, as described below, will not fully address the problem because heating damage may occur between inspections.

1. Inform biomedical engineering departments of the problem so that its early signs—discolored or deformed insulation on the power cord—can be identified.

2. Until additional information is available, do the following:
   A. For hospitals with biomedical technicians trained to service these units:
      Inspect the power supply, cord, and switch on all 2008H and 2008K units immediately, and then,

On the plug end of the replacement cords, next to the main label, the hospital found a small, additional label that was not on the old cords. This label may indicate that the replacements are new models.
as described in the service bulletin, perform this inspection as part of your quarterly preventive maintenance. If signs of overheating are present, contact Fresenius as soon as possible to have the unit repaired or parts replaced. We recommend that hospitals continue these inspections even if they replace the power cords because we cannot confirm that the replacement cords fix the problem.

B. For hospitals whose biomedical technicians are not trained to service these units:

Contact Fresenius directly and request inspections of all 2008H and 2008K units. Also, set up regular manufacturer inspections.

UMDNS term. Hemodialysis Units [11-218]

Supplier. Fresenius Medical Care North America [312187], Lexington, Massachusetts (USA); +1 (800) 662-1237, +1 (781) 402-9000; www.fmcna.com

ECRI’s User Experience Network

User Experience Network™ (UEN™) articles describe problems that ECRI believes are unlikely to pose a significant risk of harm. Most describe common or nuisance problems that can be corrected with an available modification or revised operating or maintenance procedures. Typically, they include the hospital’s report and ECRI’s comment. When appropriate, they also include the supplier’s response and recommendations for corrective action.
Introducing the

Health Devices Achievement Award

Honoring Excellence in the Field of Health Technology Management

For 35 years, we at Health Devices have worked to improve the effectiveness, safety, and economy of healthcare through the Health Devices System family of information services. Now, we’d like to formally recognize our members’ efforts in meeting these same objectives.

To celebrate our 35th anniversary, we are instituting the Health Devices Achievement Award. This new, annual award gives us the opportunity to honor excellence in the field of health technology management. We will present the award to the member or team of members that describes the most exceptional example of an initiative undertaken at their healthcare facility to improve patient safety, reduce costs, or otherwise facilitate better strategic management of health technology.

Initiatives may relate to any health technology management endeavor, including the following:

✔ Patient safety
✔ Technology selection and service
✔ Resource allocation
✔ Hazard and recall management
✔ Staff training
✔ Accreditation

What we need. Applicants should submit a 1,000- to 2,000-word essay to ECRI describing an initiative (or initiatives) undertaken at their facility that demonstrates excellence in the field of health technology management.* Relevant details to provide include the following:

1. A description of the initiative.
2. The motivation behind the initiative.
3. The methodology used.
4. The impact of the initiative, including outcomes and cost savings (as applicable). Be sure to specify whether the impacts described have been fully realized or whether they are preliminary or projected. It may be helpful to provide specific results or relevant examples of the initiative’s impact.

Applications due April 21, 2006

Submissions should also include the institution’s name; the name and title of a contact person for the submission, along with a phone number and e-mail address; and the department or departments that initiated the program.

When we need it. The deadline for submissions is Friday, April 21, 2006.

Where to send your submission. Essays can be submitted to ECRI either electronically or in paper form by

- completing the online submission form available through your membership home page at www.ecri.org,
- e-mailing a submission to communications@ecri.org,
- faxing it to (610) 834-1275, or
- mailing it to ECRI, 5200 Butler Pike, Plymouth Meeting, PA 19462, USA

All communications should be sent Attention: Health Devices Achievement Award. Also, be sure to include the necessary identifying information, as outlined above.

How we’ll judge the submissions. Submissions will be reviewed by a panel of independent judges and by members of ECRI’s staff.

Where we’ll announce the winner. The winner of the 2006 Health Devices Achievement Award will be announced at this year’s Association for the Advancement of Medical Instrumentation (AAMI) conference, which will be held in Washington, D.C., on June 24-26, 2006.

The winner will receive a plaque honoring the accomplishment and will be featured in ECRI’s Health Devices journal and on ECRI’s Web site. In addition, the winner’s contributions to the field of health technology management may be highlighted in Health Devices System promotions.

We look forward to hearing from you.

* Applicants must represent a healthcare facility that is a current member of the Health Devices System, Health Devices Online, HDgold, or SELECT-plus. Submissions will not be returned. In addition to honoring the award winner, ECRI may share other exceptional submissions with the healthcare community through its publications, online services, and promotions.
Health Devices System

Objectives

To improve the effectiveness, safety, and economy of health services by:

1. Providing independent, objective judgment for selecting, purchasing, managing, and using medical devices, equipment, and systems.

2. Functioning as an information clearing-house for hazards and deficiencies in medical devices.

3. Encouraging the improvement of medical devices through an informed marketplace.