ISMP Medication Safety Alert!®
Ambulatory Surgery Centers
Educating the Healthcare Community About Safe Medcation Practices
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Surgical fires caused by skin preps and ointments: Rare but dangerous and preventable

Problem: Surgical fires that ignite in or around patients can have devastating consequences, particularly if oxygen sources are present during head, face, neck, or upper chest surgeries.[1] It is estimated that up to 240 surgical fires occur each year in the US in operating rooms or during procedures in physicians' offices or clinics, making the frequency of their occurrence comparable to that of other surgical mishaps such as wrong-site surgery or retained instruments.[2-5] Surgical fires are considered rare but very dangerous events given the millions of surgical procedures performed each year. About 30 fires per year cause disfiguring or disabling injuries to patients, and one or two fires each year result in fatalities, most often from airway fires. A US Food and Drug Administration (FDA) analysis of thermal injuries and deaths associated with energy-based devices used in virtually every operation found that surgical fires were most common with monopolar "Bovie" instruments when they were used in head and neck operations.[6]

Although a centralized database of surgical fires in the US does not exist, agencies such as ECRI, which has extensive experience in surgical fire investigation and prevention, suggest that the incidence of surgical fires has decreased in the last decade.[7] The decline is due in large part to national initiatives promoted by professional organizations such as the American Society of Anesthesiologists (ASA), Anesthesia Patient Safety Foundation (APSF), American College of Surgeons (ACS), American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS), ECRI, Association of periOperative Registered Nurses (AORN), The Joint Commission (TJC), and FDA.[1] Despite this decline, attention must be paid to this very real threat to patient and staff safety, as virtually all surgical fires are preventable.[1-8]

How surgical fires start

Surgical fires occur when the three elements that support combustion—an ignition source, a fuel source, and an oxidizer—come together under the right conditions.[4,5,8] Ignition sources, which are often under the control of the surgeon, can be anything that produces heat, such as electrosurgical units and electrocautery devices, lasers, fiberoptic cables and light sources, drills, saws, and defibrillators. Even static electricity can serve as an ignition for a flammable fuel source. Almost anything flammable can be a fuel source, including linens, drapes, gowns, hair, and flammable pharmaceutical products (**Table 1**). The primary oxidizers leading to surgical fires are oxygen and nitrous oxide.

Table 1. Examples of common pharmaceutical-based fuels used during surgery and procedures[1,15]

Aerosol adhesives
Alcohol (also in suture packs)
Collodion
Degreasers (ether, acetone)
Numbing agents (ethyl chloride)
Skin preps with high alcohol (70% or greater) content
Tinctures (e.g., benzoin with 74-80% alcohol)
Petrolatum-based dressings/ointments (petroleum jelly)
Paraffin, white wax

Most reported surgical fires involve electrosurgical units and lasers as the ignition source, oxygen-rich atmospheres as the oxidizer, and alcohol-based surgical preps as the fuel.[1] However, because enriched oxygen and nitrous oxide environments can vastly increase the flammability of potential fuels,[1,9] organizations investigating surgical fires have sometimes incorrectly assumed

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Welcome!

Welcome to the premier issue of the ***ISMP Medication Safety Alert!® for Ambulatory Surgery Centers***, a medication safety newsletter from the Institute for Safe Medication Practices (ISMP). Written by medication safety professionals and edited by a diverse, expert perioperative advisory board, this peer reviewed newsletter is designed to:

- **Alert** ambulatory surgery center (ASC) practitioners to serious medication hazards
- **Inform** ASC practitioners about the deeply rooted causes of perioperative medication errors
- **Empower** ASC practitioners to protect patients from medication errors
- **Engage** ASC practitioners as integral members of interdisciplinary medication safety teams

To achieve these goals, we will bring you anonymous medication safety stories—sometimes amusing, sometimes tragic, but always memorable—that ISMP has received. We will talk about why mistakes happen, and offer practical advice on how to avoid errors.

Just as important, you will have a chance to share your safety stories, ask questions, and participate in surveys so we can learn about you, your medication safety concerns, and the innovative ways that you make patients safe.

We are glad you are joining us on this very important journey to prevent medication errors.

to the point

"Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has."
—-Margaret Mead

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the fuel was a prep solution when it was actually a drape, gauze, or another flammable fuel source.[7] Alcohol-based prep solutions that have not fully evaporated before draping can result in vapors under the drapes, also presenting a fire hazard. Alcohol fires may be difficult to detect because the flames may be invisible under bright surgical lights.[1]

MERP reports of surgical fires

From time to time, surgical fires have been reported to the voluntary ***ISMP National Medication Errors Reporting Program*** *(ISMP MERP)*, mostly involving flammable medications in the form of surgical skin preps containing alcohol or alcohol-containing iodophors; eye lubricants and ointments containing petrolatum; wound dressings containing tincture of benzoin or collodion; and skin numbing agents containing ethyl chloride.

One surgical fire reported to ISMP involved **GEBAUER'S ETHYL CHLORIDE** spray, which had been applied as a numbing agent to a patient's big toe prior to a minor surgical procedure. During the procedure, electrocautery was used, causing ignition of the ethyl chloride. The surgeon was able to quickly smother the flame; however, the patient suffered first-degree burns on his toe which required wound care. The front panel label on the ethyl chloride bottle includes a small icon of a flame (**Figure 1**), and the side panel of the outer carton warns, buried in dense text, that it should never be used in the presence of an open flame or electrical cautery equipment. However, the surgeon overlooked these inconspicuous warnings and was unaware of these risks.

Figure 1. Gebauer's Ethel Chloride has a "flame" icon (bottom right) that was ineffective in communicating its flammability.

Another surgical fire reported to ISMP happened in an ambulatory surgery facility. An assistant surgeon had prepared an operative incision for bandaging by spraying it with tincture of benzoin. The primary surgeon had nearly completed suturing the patient's incision, but he noticed a small bleeding area along the incision line and decided to cauterize it. The flammable benzoin ignited briefly, but fortunately, the patient was not harmed.

Earlier, ISMP published several reports of surgical fires in our acute care newsletter,[11,12] some associated with flammable products that are no longer available, including **CHLORAPREP ONE-STEP** (2% chlorhexidine gluconate, 70% isopropyl alcohol), an antiseptic surgical skin prep solution, and tincture of benzoin, a topical antiseptic. One surgical fire involved an ocular lubricant (white petrolatum and mineral oil ophthalmic ointment [**LACRI-LUBE S.O.P.**]) used for a young child during laser surgery to remove warts near his eyes.[11] The child suffered burns to his eyelids and periorbital area. Two other surgical fires involved Gebauer's Ethyl Chloride spray. One case happened in a physician's office, where a 6-year-old child was undergoing a procedure for an infected toe.[10] A nurse practitioner had sprayed the toe with ethyl chloride and then lanced the area using electrocautery, which caused the pad under the child's foot to ignite in flames. The child's mother immediately pulled her son away from the fire, so he did not suffer any burns. The nurse practitioner had observed a physician performing the same procedure on another child without problems, and she was unaware of the fire hazard when using ethyl chloride. In the other case, a physician applied ethyl chloride spray to an abscess on a girl's forehead and waited for it to dry.[12] He then used electrocautery to drain the abscess. Due to hair loss, the teenager was wearing a flammable synthetic wig, which ignited after the cautery was applied to her forehead. The patient sustained first-degree burns to her ear.

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SAFETY*briefs*

Insulin and tranexamic acid mix-up.

Two serious medication errors were reported due to look-alike 100 mL bags of insulin and tranexamic acid that had been compounded in a pharmacy. The first error occurred when a pharmacy technician retrieved a 100 units/100 mL bag of insulin from the pharmacy refrigerator instead of the tranexamic acid that was also stored there. The bag of insulin was dispensed to a freestanding ambulatory surgery center (ASC), where barcode scanning was not utilized. A 1 g dose of intravenous (IV) tranexamic acid was to be given over 15 minutes, but the insulin was administered in error. Staff in the recovery area recognized the error, discontinued the insulin, and monitored the patient's blood glucose level. Dextrose IV was administered, and the patient suffered no permanent harm.

A similar error happened when an anesthesiologist hung an insulin bag instead of tranexamic acid, both of which were stored in an ASC automated dispensing cabinet. The error was caught after the entire insulin bag had been infused. Again, the patient was monitored once the error was noticed, IV dextrose was administered, and no significant harm occurred.

Two factors stand out as contributing to the above cases. Both medications were in 100 mL bags, and both had similar looking white labels with small text that was difficult

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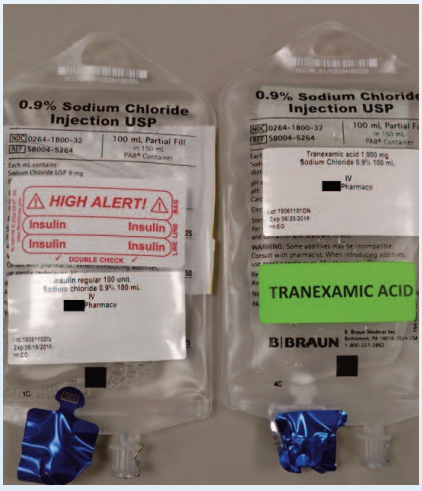

Figure 1. Because the drug names do not stand out on the small, white pharmacy labels on insulin (left) and tranexamic acid (right) bags, the pharmacy now affixes auxiliary labels. (A patient-specific label [insulin] and an additional auxiliary label [tranexamic acid] are also on the back of the bags.)

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Safe Practice Recommendations: In recent years, a growing awareness of the risks leading to surgical fires has led to an increasing number of organizations that are incorporating surgical fire safety into formal patient safety initiatives. In-depth resources to guide these initiatives are freely available from various professional organizations, many of which have been compiled on the ECRI, Council on Surgical & Perioperative Safety, and APSF websites. When using pharmaceutical products that may serve as a fuel source for surgical fires, consider the following recommendations.

Take inventory. Make a list of all potentially flammable pharmaceutical products (e.g., surgical skin preps and ointments) used in your organization's procedural locations (including operating room suites, doctors' offices, clinics, and ambulatory surgery units).

Evaluate the list. Evaluate the need for each flammable pharmaceutical product used in your facility, as there may be safer alternatives, especially for topical anesthetics. While selection of an appropriate topical anesthetic or surgical skin prep solution is beyond the scope of this article, factors such as flammability should be a consideration to ensure the safe care of patients.

Ensure awareness. Ensure that physicians, anesthesia providers, nurse practitioners, nurses, surgical assistants, and other practitioners know about the dangers of any flammable pharmaceutical products used in your facility, as well as the potential for burns when these products are used in conjunction with an ignition source and oxidizer.

Affix auxiliary labeling. If the manufacturers' labels on flammable skin preps and ointments are not prominent or distinctive (e.g., Gebauer's Ethyl Chloride containers), consider affixing auxiliary labels to the packages prior to dispensing to warn about flammability and the directions for proper use.

Provide and select proper applicator sizes. Select properly sized prefilled applicators of alcohol-based surgical skin prep solutions for the area needing coverage to prevent pooling and reduce the amount of excess prep requiring disposal and removal.

Avoid pooling. Ensure pooling, spilling, or wicking of a flammable surgical skin prep does not occur during or after application.

Ensure adequate drying time. Allow adequate drying time of the skin prep before application of the drapes or surgical barriers, or before beginning the procedure (e.g., at least 3 minutes for most alcohol-based skin preps, unless applied to hairy skin or in body folds, which may take up to 1 hour to dry). If possible, keep alcohol-containing prep solutions out of the patient's hair. Consider including drying times on a surgical safety checklist to encourage communication between surgical team members.

Dispose of flammable surgical skin prep agents properly. Soak up spilled or pooled skin prep agents and remove any excess or remaining flammable prep solutions or ointments from the room prior to the use of any ignition source. Dispose of unused flammable skin prep agents in a manner to decrease the risk of fire.

Minimize the use of supplemental oxygen. Given the extensive role that oxygen plays as an oxidizer and accelerant in surgical fires, avoid the delivery of supplemental oxygen as a matter of routine. Use only air for open delivery to the face if the patient can maintain a safe blood oxygen saturation without supplemental oxygen.[1,8] If the patient cannot maintain a safe oxygen saturation without supplemental oxygen, secure the airway with a laryngeal mask airway or tracheal tube.[8] For cases in which

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to read. The information that stands out on the pharmacy label was the route of administration and the name of the pharmacy. No barcode was available on the pharmacy label; however, had the bags been scanned in the pharmacy at the time of dispensing, at least one of these errors would have been prevented. Unfortunately, most ASCs have yet to deploy barcode scanning, which is critical for preventing these types of errors in this setting. The pharmacy that supplies the ASC with medications is now applying auxiliary labels to the bags to help to identify their contents (**Figure 1**, page 2).

For safety, switch from phenol bottles to applicators. Painful ingrown toenails are commonly treated surgically by excising a section of the nail or an entire nail plate after matricectomy (the process of destroying all or part of the base nail portion called the nail matrix). Once destroyed, the portion of the nail removed cannot be regenerated and the problem is expected to resolve. During the procedure, local anesthetic is injected into the base or proximal aspect of the toe before the nail matrix is destroyed chemically using phenol.

Phenol, or carbolic acid, is a hazardous chemical that can result in burns when mishandled. One error report detailed a case involving a 17-year-old patient for whom

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Figure 1a. Phenol burn is evident after 1 day.

Figure 1b. Significant dermal changes noted after 9 days.

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open oxygen delivery is essential, deliver only the minimum concentration of oxygen necessary to maintain an adequate oxygenation.[1]

Promote communication. Consider adding a "Surgical Fire Risk Assessment Score"[13-15] to the preoperative time-out process that requires the surgical team to identify if flammable materials (including skin preps and ointments), oxidizers (e.g., supplemental oxygen), and potential ignition sources will be used during the procedure to assess the risk of a surgical fire, and to develop a plan to mitigate any risk.[7] Such a tool can also promote intra-procedure communication between providers. For example, after reviewing the risk of a surgical fire, anesthesia providers may be more likely to make the surgeon aware of any open oxygen use with the patient, and surgeons may be more likely to notify anesthesia providers prior to using electrical devices so the oxygen concentration can be lowered (preferably to 21%) at least 1 minute before using the electrical device.[1]

Provide annual training. Conduct annual training on the causes, prevention, and extinguishment of surgical fires. Review the specific directions for use of all potentially flammable surgical skin preps and ointments that might be used in your organization. Provide directions for controlling heat sources (ignitions), managing potential fuels (including surgical skin preps and ointments), and minimizing oxygen- and nitrous oxide-enriched environments. Require all physicians, anesthesia providers, nurse practitioners, nurses, surgical assistants, and other professionals who work in procedural areas to attend the annual training program. Consider holding a surgical fire drill immediately after training to evaluate effectiveness.

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Editors: Judy Smetzer, BSN, RN, FISMP; Michael Cohen, RPh, MS, ScD (hon), DPS (hon), FASHP; Ann Shastay, MSN, RN, AOCN; Russell Jenkins, MD; Kelley Shultz, MD. ISMP, 200 Lakeside Drive, Suite 200, Horsham, PA 19044. Email: ismpinfo@ismp.org; Tel: 215-947-7797; Fax: 215-914-1492.

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phenol was being used during a matricectomy for treatment of an ingrown toenail. An unlabeled bowl of what was thought to be saline solution was used to cleanse the patient's foot, but it actually held phenol. The patient experienced a burning sensation which led to the realization that phenol was in the bowl, not normal saline. Although poison control services were contacted and first aid was provided, the condition worsened (**Figures 1a** and **1b,** page 3) and required transfer to a hospital with a burn center.

We are also aware of an incident in which phenol was injected into the toe instead of the local anesthetic, as well as an event in which a look-alike bottle of collodion skin adhesive was mixed up with a bottle of liquified phenol, which was applied to a surgical wound causing an immediate skin reaction.

Never decant phenol or any other liquid into an unlabeled container used concurrently during surgery or any other procedure. This has often contributed to mix-ups and has caused error-related tissue injury and death.

If phenol is stored and/or used in your facility, determine why it is being used and whether alternatives are plausible. Many facilities stock bottles of phenol without realizing there are prepackaged phenol swabs with a small amount of phenol in an ampul-like container (**Figures 2a** and **2b**) for use during procedures. These are much safer than bottles of liquid phenol and reduce the risk of a mix-up with other solutions as well as reduce staff exposure to phenol. If phenol is available, be prepared for immediate treatment should the substance be mishandled. Staff in the above case did not know to take proper precautions if an error occurred. Polyethylene glycol 300 (PEG 300) solution should be kept with phenol for decontamination of unintended skin exposure.

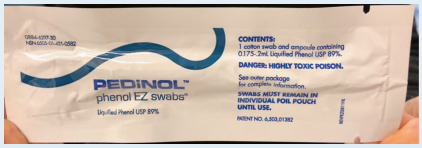

Figure 2a. A single phenol applicator holding just 0.175 to 0.2 mL is enclosed in this package.

Figure 2b. Phenol applicator.