

A Burning Issue

Preventing Patient Fires in the Operating Room

WHAT can you say to a patient having a skin lesion excised under monitored anesthesia care (MAC) who suffers severe burns to the neck and face from a surgical-site fire caused by unnecessary supplemental nasal cannula oxygen leaking under drapes and towels into the surgical field where electrocautery was used? “Oops!” is clearly insufficient. Although “I’m sorry” and then an outline of exactly what happened may be a start, there is often a significant difference between an explanation and an excuse. With the recent widespread emphasis on the risk of surgical-site fires and new knowledge about the flammability of surgical drapes and materials, there can be no excuse.

In this issue of the journal, Culp *et al.*¹ squarely address this emphasis on the risk of surgical-site fires that was echoed very recently in the report of the American Society of Anesthesiologists Closed Claims Study analysis of operating room fires.² Culp *et al.* demonstrated the flammability of the drapes and towels used to create surgical fields and the sponges used during surgery. Furthermore, particularly, the authors showed huge (and dangerous) increases in flammability of these materials in oxygen-enriched environments. Some anesthesia professionals may think that this is intuitively obvious from basic chemistry, but it is the time measurements using stop-action video at 30 frames a second that provide their dramatic results. The authors used a standardized test method used for garment fabric and used a common match as an ignition source, which burns at 200°C less than the temperature of the spark from a monopolar electrocautery that burns tissue to stop bleeding. For a cotton surgical sponge, the ignition times were 0.9 s in 21% oxygen (room air), 0.3 s in 50% oxygen, and less than 0.1 s in 100% oxygen. Times for the standard-sized samples to burn completely were 27, 2, and 0.8 s, respectively. For the routine



“Patient burns from surgical-site fires in superficial upper body surgeries ... under MAC can be prevented right now.”

blue cotton towel that forms the edges of so many surgical sites, ignition was 1.6 s in room air and 0.1 s in 100% oxygen. Towel samples burned up completely within 22 s in room air and 0.9 s in 100% oxygen. These results showing increased flammability are both remarkable and consistent with the concept that most oxygen-enhanced surgical-site fires occur so rapidly that even the quickest response from the operating team cannot prevent patient burns. The “paper drapes” commonly used to cover patients on the operating table (including the patient’s head and face during many procedures on the upper torso, neck, and head), which are mostly made of the organic polymer polypropylene, ignite and burn much faster in 100% oxygen (note that the surgical drapes burned in 81% of MAC case fires reported to the American Society of Anesthesiologists Closed Claims Study³ and that supplemental oxygen was being administered in 100% of those cases.) Even surgical gowns, which are almost entirely made of polypropylene and which do not ignite in room air, ignite and burn almost instantly in 100% oxygen.

These findings show truly dramatic oxygen-enriched facilitation of flammability of the materials comprising a surgical field. They must serve as a warning to those anesthesia professionals who apparently still do not appreciate the great risks caused by open supplemental oxygen, usually from nasal cannulae covered by a drape over the head, leaking into a surgical site where electrocautery will be used. These practitioners still place nasal cannulae or even a perforated plastic face mask (preferred by some in order to keep the surgical drape off the patient’s face) and administer 2 or 3 l/min of oxygen for every single MAC case, including for perfectly healthy patients. This is done allegedly out of concern that IV “sedation” with benzodiazepines, narcotics, and hypnotics such as propofol will cause hypoxemia manifest as hemoglobin desaturation

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Accepted for publication June 17, 2013. Dr. Eichhorn is a Consultant to the Executive Committee of the Anesthesia Patient Safety Foundation, which produced and distributes the cited fire safety video.

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◆ This Editorial View accompanies the following article: Culp WC Jr, Kimbrough BA, Luna S: Flammability of surgical drapes and materials in varying concentrations of oxygen. ANESTHESIOLOGY 2013; 119:770–6.

on the pulse oximeter. Confusion about the distinction between adequacy of spontaneous ventilation and adequate oxygenation along with the fact that supplemental oxygen significantly diminishes any potential value oximetry may have as a surrogate ventilation monitor are not the subject of this editorial. However, the concepts are relevant because they contribute to the dangerous oversimplifications that promote routine supplemental oxygen administration in these circumstances: “It’s such a simple case—just a lump on the neck with local and sedation...” and, of course, “That’s what I was taught; it’s the way we always do it.”

The American Society of Anesthesiologists Closed Claims Study analysis of operating room fires² reiterates: “Many anesthesiologists and surgeons remain unaware of fire risks in the OR...” That database shows that electrocautery was the ignition source of 90% of all reported fires. Of these, 81% were during MAC and 85% were during head, neck, or upper chest cases (termed “high-fire-risk” procedures). Importantly, supplemental oxygen was being administered *via* an open delivery system (nasal cannulae or face mask) in 100% of those “high-fire-risk procedures” when fire then did occur.

Although it is valid for Culp *et al.* to opine that potential future research should help make surgical drapes and materials less flammable and thus help prevent surgical-site fires, in practical reality it is anesthesia professionals who hold the key, right now, to prevent the vast majority of surgical fires. Surgical-site fires have *not* been reported in, for example, orthopedic surgery on a leg, where there are the same drapes, towels, sponges, and electrocautery—but *not* an oxygen-enriched environment. The supplemental open oxygen delivery during MAC procedures done anywhere above the nipple line is the controllable factor. In addition to the classic superficial procedure on the shoulders, neck, or head, this includes procedures such as placement of central venous ports or pacemakers (both sometimes seen in patients who really do need supplemental oxygen). There will be surgical drapes, blue towels, and sponges (fuel), and there will be monopolar electrocautery (ignition source) used in upper body superficial procedures under MAC. The third side of the “fire triangle” is the oxidizer, the supplemental oxygen administered by the anesthesia professional. For now, this must be the element modified to prevent setting patients on fire.

Eliminating open delivery of supplemental oxygen (nasal cannulae or face mask) during upper body MAC procedures has been the focus of recent extensive authoritative analysis of the problem of fires burning patients⁴ and in a parallel dramatic video readily available from the Anesthesia Patient Safety Foundation.* In essence, supplemental oxygen is overused and is very often not truly necessary. As noted,

habits die hard. It might in some circumstances take more attention and effort for an anesthesia professional to manage the sedation during a MAC case when the pulse oximeter could read less than the typical and convenient constant 99 or 100% seen when supplemental oxygen is on. That is a small price for the confidence that the risk of fire is reduced to an absolute minimum by eliminating the supplemental oxygen. When oxygen is used nonetheless, various risk mitigation strategies have been cited as lesser, intermediate approaches. Wetting all the sponges may sometimes help one specific component. Placing wall suction tubing between the operative site and the patient’s face under the drape is unreliable. “Opening up” the draping so there is no space for oxygen to accumulate and build up pressure that would force it into the surgical field seems logical but is difficult to achieve without limiting the surgeons’ positioning and access to the field. “Sealing” the surgical site with an adhesive “sticky drape” to prevent oxygen entry may briefly reduce risk in some cases—until the patient’s sweat and skin oils and also surgical irrigation fluid loosen the plastic sheeting. Finally, having the surgeon announce the need for electrocautery use so that the anesthesia professional can discontinue supplemental oxygen and have everyone wait quietly for several minutes before the cautery can be used will inevitably try the surgeon’s patience and also may deprive any truly oxygen-dependent patients of necessary support.

The patient who is genuinely oxygen dependent and needs a superficial upper body surgical procedure that in most circumstances would be performed with MAC has provoked discussions. The only logical, although somewhat controversial, conclusion is that this type of patient should receive a “light” general anesthetic using a gas-sealing airway—a laryngeal mask or an endotracheal tube. Argument could be made that this adds additional risk, but a counterpoint is that such fragile patients are most at risk of overseddation, hypoventilation, and hypoxemia during a traditional MAC case. Experience over time, including, unfortunately, more malpractice lawsuits after patient burns from surgical-site fires during upper body MAC cases, will likely support a trend to controlled airways for these truly oxygen-dependent patients rather than open oxygen administration under a surgical drape.

Although Culp *et al.* did not include consideration of residual alcohol-based surgical prep solution as the fuel for surgical fires, this alternative scenario has been documented⁵ and emphasized.⁴ The same concepts apply. Residual alcohol will ignite and burn in room air, but just as these authors showed with sponges, towels, and surgical drapes, it will do so much faster and more intensely in an oxygen-enriched surgical-site environment, increasing the already formidable risk of patient burns.

It is necessary for the profession of anesthesiology, the directors of resident training program curricula, the organizers of Continuing Medical Education courses, and anesthesia

* Anesthesia Patient Safety Foundation. Fire Safety Video: Prevention and Management of Operating Room Fires. Available at: http://www.apsf.org/resources_video.php. Accessed May 1, 2013.

professionals everywhere to recognize the implications of the flammability of surgical drapes and materials and, especially, the dramatically increased flammability in oxygen-enriched environments. Patient burns from surgical-site fires in superficial upper body surgeries conducted under MAC can be prevented right now. This will happen when new practice habits are formed, and inappropriate open-source supplemental oxygen under closed drapes is eliminated—due to the new version of ... “That’s what I was taught; it’s the way we always do it.”

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From Lynch to Knight to Wood: An Inscribed Esmarch Chloroform Kit



The famous German surgeon Johannes Friedrich August von Esmarch (1823–1908) described his namesake chloroform inhaler by 1877. The complete kit would eventually include a chloroform dropper bottle (center), the wireframe mask, gauze, minor tools, and a leather carrying case (left). This example has the flat hinged back of its case inscribed (right) with: “TO MY FRIEND / RALPH T. KNIGHT, M.D. / FROM / MATTHEW J. LYNCH, M.D. / MINNEAPOLIS / MINN.” Eight years after serving as the 1953 president of the American Society of Anesthesiologists, Dr. Knight received the ASA’s Distinguished Service Award. This Esmarch Chloroform Kit was passed from Dr. Lynch to Dr. Knight to the library-museum founded for the ASA by Dr. Paul Meyer Wood. (Copyright © the American Society of Anesthesiologists, Inc.)

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