PREVENTION OF FIRE IN THE DENTAL CHAIR

We all believe that we know about fire safety and rarely think about having a fire in the dental chair that could cause serious injury or death to a patient. Yet fires are not uncommon in hospital operating rooms and also have occurred in dental offices. It is estimated that 600 surgical fires occur yearly in hospitals.¹ Although hospitals are required by the Joint Commission to report fires, we do not know whether such incidences are increasing in dental offices. We do know that they can be devastating to both the patient and the doctor. So how can the individual dentist improve the margin of safety to prevent such a disaster from occurring? We all need to be aware that we must control a number of fire risk factors that are ever present during dental treatments, especially those involving sedation or general anesthesia where oxygen is delivered.

It is common knowledge that fires require three essential ingredients, the so-called fire triangle: a source of fuel, a source of heat sufficient to cause ignition, and the presence of oxygen (or any other oxidizer such as nitrous oxide). Each side of the fire triangle contains obvious (and some not-so-obvious) components that are commonly found in the dental office or operating room. Although we understand that fire can be prevented by taking away any one of the three elements, we also know that modern dental treatments, especially involving sedation or general anesthesia, often require the presence of all three of the triangle's components to facilitate a good surgical outcome. Thus our goal is to keep them as far apart as reasonably possible, but that can be very difficult since dentists are usually working in and around the airway, where oxygen abounds.

Common materials used in dentistry, such as tape, gauze packs, cotton rolls, throat screens, and sterile drapes and towels, are all obvious sources of fuel for a fire. If possible, these fuels must be kept moist throughout the procedure to reduce their flammability. Headrest covers, egg-crate foam padding, rubber dams, nasal canulas, oxygen masks, nasal hoods, and endotracheal tubes are also sources of fuel and should be shielded from accidentally coming in contact with a heat source such as a laser. Moist sterile towels can be placed over water-resistant paper sterile drapes or other non-water-absorbing materials to protect them from igniting. Adhesive clear plastic incise drapes are flammable in oxygen-enriched environments. Some less obvious sources of fuel include the material covering fiber-optic cables, BIS monitor cables and pads, and ECG wires.

Skin prep solutions containing a significant amount of alcohol are supposed to dry before the procedure is started, but especially when they soak into drapes and towels or pool beneath the neck, vapors from these solutions can collect under sterile drapes and have been known to result in a ball of flames when ignited by a source of intense heat in an oxygen-rich atmosphere. Aerosol adhesives and liquids such as tincture of benzoin (75–80% alcohol) are highly flammable fuels. While a large glob of petroleum jelly (Vaseline) or antibiotic ointment might absorb considerable heat before vaporizing and igniting, a thin coat on the lips or skin needs less heat to ignite, especially in the presence of high concentrations of oxygen. Hair, including facial hair, hair nets, and caps, is another commonly neglected source of fuel that is in close proximity to oral surgical procedures. Water-based lubricants, such as K-Y jelly, are primarily water and will not burn since heat vaporizes the water in the lubricant and cools the area. Water-based lubricants can actually be used to coat hair to make it more fire resistant. Any measure that will reduce the contact of fuel with the other two components of the fire triangle or reduce their flammability will increase the margin of fire safety.

Electrocautery, electrosurgery, and laser units, as well as fiber-optic light units and cables, are very common sources of intense heat in the dental office. Even sparks from a high-speed drill contacting hard tissue or metal plates and screws can ignite a fire if a dry gauze throat screen and a high concentration of oxygen are present. It would be difficult to eliminate all of the very useful and necessary heat-producing devices and tools from modern dental practices in order to eliminate the possibility of a fire. To help prevent an intraoperative fire, we must treat these instruments as we would a loaded gun and be continually aware that we cannot allow even a brief lapse in safety precautions. For instance, when not in use, even for a few seconds, cautery handpieces must always be kept in their holsters rather than being briefly placed directly on the patient's drapes. The surgeon should be the only one to activate the device and only when its tip is in his or her direct view. Contaminated tips must be disconnected and removed from the surgical field, lest they be accidentally activated. Keep only those necessary foot-activated switches in the surgical area and keep them as far away from each other as possible to prevent activating the wrong one. Keep fiber-optic light sources in the standby mode or turned off when disconnecting the cables and never place the cables on the drapes or on other flammable materials.

The administration of supplemental oxygen to patients during sedation and general anesthesia would be difficult to entirely eliminate because respiratory complications due to hypoxemia are the single most likely cause of serious morbidity and mortality associated with sedation and general anesthesia. Supplemental oxygen given during deep sedation or general anesthesia before a laryngospasm or upper airway obstruction occurs increases the time available to correct the problem before life-threatening hypoxemia develops. However, the administration of oxygen does increase the risk of an intraoperative fire. In fact, in vitro studies simulating operating room fires indicate that without an oxygen-enriched environment, many flammable materials used in surgery that come in contact with an intense heat source tend to initially smolder before developing a flame, or they might even self-extinguish. However in an oxygen-enriched environment, a flash fire can occur and cause tremendous damage before the surgical team can react. Supplemental oxygen can build up in high concentrations under surgical drapes when tented over a patient's head, and they can travel great distances under the drapes and exit near a remote surgical site such as a hip graft harvesting area. When this oxygen is combined with a fuel and even just a spark as an ignition source, a tremendous ball of fire can erupt. Therefore, it is recommended that we reduce the concentration or even completely eliminate supplemental oxygen if medically acceptable when an intense heat source must be used near a fuel. Anesthesia machines that can deliver air as well as oxygen can provide a modest oxygen concentration of perhaps 30% that will maintain an acceptable pulse oximeter reading while reducing the potential for a flash fire. Since thermal decomposition of nitrous oxide liberates oxygen, diluting the oxygen with nitrous oxide is not helpful. In dental offices, one could stop the flow of supplemental oxygen for a minute and ensure that oxygen is not trapped under the surgical drapes before the cautery or laser is used, particularly if a potential source of fuel is in proximity to the heat.

The Emergency Care Research Institute, an independent, nonprofit organization that researches the best approaches for improving the safety, quality, and cost-

effectiveness of patient care, published the following case report²:

A patient was undergoing maxillofacial surgery with general anesthesia maintained through a nose mask with a concentration of 25% oxygen, 75% nitrous oxide, and a small percentage of halogenated anesthetic. The patient had a moustache. As the surgeon was grinding a filling with a tungsten-carbide bur, an incandescent spark flew from the bur and arced out of the patient's mouth, over his upper lip, and landed in his moustache. Because of the high concentration of oxygen, effectively 50% because of the nitrous oxide, the moustache immediately burst into flame and ignited the nasal mask. The fire then flashed back toward the anesthesia machine along the gas delivery hoses. As soon as the fire was noticed, the nasal mask was removed from the patient's face, but not before significant burning of his nose and upper lip had occurred. Had a water-based lubricant been used to coat the moustache hair, the spark would not have caused the fire.

This sobering case report clearly illustrates that this could have easily been in your office or my operating room. Should a fire occur despite our best efforts, we must recognize that the initial burn is typically much worse than what it looks like soon after the fire is extinguished. What may at first appear to be a mild sunburn can result in a significant injury. Furthermore, an inhalation fire injury can be quickly fatal. I strongly urge all of our readers to re-evaluate their dental practices to see where they can improve on fire safety. While it is not reasonable or wise to abandon the use of oxygen in the office, it must be used carefully to avoid a fire in the dental chair. Let's not depend on our past good luck to prevent a fire in the future.

Joel M. Weaver, DDS, PhD
Editor-in-Chief

1. ECRI Institute. New clinical guide to surgical fire prevention. Patients can catch fire—here's how to keep them safer. *Health Devices*. 2009;38:314–332.

2. ECRI Institute. The patient is on fire. A surgical fires primer. *Guidance*. 1992;21(1):19–34.