Fire in the Operating Room: A Previously Unreported Ignition Source

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Abstract

Surgical fires are a serious threat to the patient and surgical team in the operating room. Burns have been reported at, and distant to, the operating site, as well as within the body. The essential point to remember is that at least 1 arm of the fire triangle—an oxidizer, fuel, and an ignition source—must be completely controlled to prevent an intraoperative fire. Here we give the example of a pulse lavage system as a possible ignition source.

Over 100 surgical fires are reported yearly, and sources indicate that many more go unreported and may be as high as 650 per year.[1,2] The creation and continuation of a fire requires 3 components: an oxidizer, a fuel, and an ignition source. This is otherwise known as the "fire triangle." In the operating room, all 3 are readily present and typically controlled by different members of the surgical team: anesthesiology controls oxidizers, nursing controls fuels, and the surgeon controls the ignition sources.[3]

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Case Report

On one occasion, a juvenile male was undergoing an irrigation and debridement for a traumatic arthrotomy of the knee sustained in a marine environment. As is customary in many centers after the debridement and irrigation was performed and before closure, all instruments used during the first phase of the procedure were removed from the field. This included cutting free, with the use of bandage scissors, the irrigation tubing and power cord attached to the low-pressure pulse lavage used for irrigation. Shortly after the case resumed to skin closure, a wisp of smoke was noted from drapes covering an arm board. Further inspection of the source of the smoke demonstrated the cut ends of the power cord, once attached to the pulse lavage gun, causing a smolder from the surgical drapes (Figure). The cord was immediately removed from the field, without further propagation of fire. There was not a resultant injury to the patient.

This fire stemmed from exposed wires that were still in continuity with the battery pack power source. The packaging was examined and no flammability caution was found. Since this incident occurred, the surgical team no longer cuts the pulse lavage power cord to remove it from the surgical field, instead it is removed in total from the field after irrigation.

Discussion

Oxidizers include ambient air, an oxygen enriched atmosphere, and nitrous oxide.[2,4] Oxygen enriched air exceeds the concentration of 21% or a partial pressure of 21.3 kPa.[2,5] This will lower the energy required to start a fire and allow the fire to burn hotter and with more intensity. Nitrous oxide supports combustion by exothermal dissociation into heat and oxygen; it will also allow a fire to burn with more intensity. Typically, these increased levels are only present around the head and neck and are controlled by the anes-

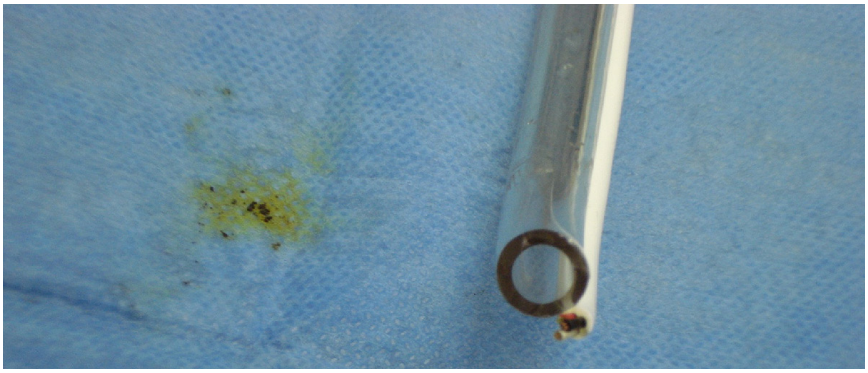

Figure. The photo demonstrates the exposed cut wires in contact with one another and the area of the drape that subsequently burned.

thesiology team.[6]

Fuels include surgical gowns and drapes, preparation solutions, tubing, body hair and tissues, and intestinal gasses.[2,4,6,7] These fuels are flammable in ambient air and this property can be enhanced by anesthesia's oxidizers. For instance, surgical drapes are flammable in ambient air when biologic material is present as a conductive agent, and time to ignition is significantly decreased with increasing oxygen concentrations.[8] Drapes made of cellulose will ignite in an average of 3 seconds and burn rapidly, making them an exceptional risk.[9] Alcohol-based preparation solutions have been shown to increase the risk of fire, as well as chemical burns to the patient.[10] Its flammability is in direct proportion to its concentration, with 100% concentration requiring only one spark to ignite.[6] Everything on and around the surgical field, including the patient, is considered flammable; nursing is considered the primary watchdog for this fire triangle.

Ignition sources include electrosurgical units, lasers, fiberoptic light sources, and defibrillators.[2,4,7] Each of these units can provide heat energy to start a fire in the presence of an oxidizer and a fuel. Electrosurgical units and defibrillators provide an electrical arc at high temperatures and may produce a flame. Lasers use electromagnetic radiation and fiberoptic sources use a concentrated beam of ultraviolet light; both of these units can produce power at hundreds of watts per square centimeter, making them capable of causing a burn injury to the patient or igniting fire in surgical drapes.[11] The surgeon controls these ignition sources.

Conclusion

Regardless of who has primary control over each element of the fire triangle, it is important for the entire team to remain aware of the risk in the operating room. As the case report above demonstrated, fires can spring up at any time, even when performing a "routine" part of a "simple" procedure with an unforeseen ignition source. The essential point to remember is that at least 1 arm of the fire triangle must be completely controlled to prevent fire. The surgical field will never be completely free of fuels or oxidizers. The patient is flammable and therefore a fuel source, and ambient air is an oxidizer. Both of these entities offer serious limitations to control. Therefore, potential sources of ignition must be readily identified and controlled to optimize fire safety.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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