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Patient Safety Tip of the Week

December 6, 2022

Rare Risk – Defibrillator Fires

It's rare, but it's a serious risk. A patient recently died after a fire triggered by defibrillator paddles (McGee 2022). The patient had been bedridden for several years and was hospitalized at TriStar Centennial Medical Center in Tennessee for bed sores and a foot infection. At the hospital, he coded and staff tried to revive him. According to his wife "…they started the paddles, and it just blew up, everything," She saw flames cover her husband's body. "He got burned in the throat, the face, the head, the chest and his hands." He was transferred to another hospital with a burn unit but ended up dying that night.

On second thought, maybe not as rare as you'd think. Last year a 69 y.o. woman died in a similar incident at a Texas hospital. That patient, who was being treated for COVID-19, was being resuscitated with a defibrillator when something caught fire and caused a small explosion (Willey 2021). Officials were looking into the presence of an open medical oxygen tank as a possible factor. And 2 years before that, at yet another Texas hospital, a defibrillator being used to resuscitate a man sparked, igniting oxygen in the room that had been left on and causing his body to catch fire (Bennett 2021). In that fire, the defibrillator used by the medical team arced and "a spark went off and ignited the oxygen in the room that had been accidentally left on" (Wright 2019).

In 2004, when paramedics were attempting to resuscitate a woman in Connecticut, a spark from defibrillator paddles started the patient's clothing on fire. And, in 2003, there was a report on a case of a fire attributable to a defibrillation attempt in a 10-day-old neonate following open-heart surgery (Theodorou 2003), with special emphasis on the importance of removing oxygen from the immediate environment during defibrillation attempts.

In our December 2015 What's New in the Patient Safety World column "Unique Ignition Sources in Surgical/OR Fires" we described an OR fire related to a cardioversion procedure occurred in Michigan (Counts 2015). Though the hospital apparently did not

release details of the incident, news releases (Allen 2015) state that a spark from the cardioverter pad ignited a paper drape and mask covering the patient in an oxygen-rich environment. That resulted in a fire that injured the patient and several staff members.

And that was not the first time that a cardioverter or defibrillator has served as the heat source for an OR fire. In 2012 an OR fire in North Carolina that was fatal to a patient was triggered by a defibrillator (WRAL 2012). And in June 25, 2013 Patient Safety Tip of the Week "Update on Surgical Fires" we discussed a study from a closed claims database (Mehta 2013) in which there was one case where a defibrillator was the heat source. The 2008 ASA Practice Advisory for the Prevention and Management of Operating Room Fires (ASA 2008) also mentions defibrillator paddles or pad as potential heat sources.

While most cases have involved use of defibrillator paddles in emergent life-saving situations, presumably the same risks would apply to patients undergoing elective cardioversions. In fact, ECRI (ECRI 2020) received a report in which a patient's beard and the oxygen mask caught on fire when the shock was delivered during cardioversion.

One of the earliest case reports of a fire during defibrillation came in 1972 (Miller 1972). In that case a spark from one of the defibrillator paddles to one of the monitoring electrodes was immediately followed by flames at the patient's neck, shoulders, upper chest, face, and head. Her hair and bed linens were in flames and flames were also noted in the oxygen face mask, which was still in place. The patient survived but the fire resulted in significant hair loss and second degree burns on the shoulder, neck, and scalp. Miller's advice rings true to today "…the person operating a defibrillator must be certain that the paddles are thoroughly covered with conductive gel and that they are in firm and complete contact with the chest wall before they are discharged. In addition, confirmation that the oxygen has been temporarily turned off must become as automatic as checking to see that no member of the resuscitation team is still in contact with the patient or the bed before the defibrillator is discharged."

Of course, you need all 3 elements of **the fire triad – fuel, oxydizer, and heat source –** for a fire to occur. The defibrillator paddles only supply the heat source. The various media reports of this incident do implicate oxygen and the patient's wife was apparently told there was a defective wire in the paddles that led to the spark. We'd be highly surprised if this occurred in the absence of a rich oxygen source. And, while almost anything can serve as a fuel source, we'd wonder whether any alcohol-based solutions or vapors might have been present.

Oxygen is arguably the most critical element in these fires. We haven't come across a case in which oxygen did not play a major role. A case described in the ASA Monitor (ASA 2020) involved defibrillation in a post-op patient who developed recurrent V-fib. In this case, the fire was ignited due to the arcing that occurred as a result of poor contact of the gel defibrillation pads with the patient's skin. After the fact, a crease in the defibrillation pad was noted with burn markings clearly visible in this crease. But an oxygen-rich environment clearly played a major role. The patient had been on oxygen via

nasal cannula at 4L/min. When the code team initially started ventilating the patient, they removed the nasal cannula from the patient and tucked it under the patient without shutting off the oxygen flow at 4 liters/minute. Secondly, when it came time to defibrillate the patient, the Ambu®-bag was disconnected from the endotracheal tube and placed next to the patient's shoulder. High flow oxygen continued to flow out of the reservoir end of the Ambu®-bag onto the patient's torso.

An APSF review on defibrillation fires (APSF 2009) cites the extensive work of the ECRI Institute. ECRI has noted cases in which the breathing circuit containing a high oxygen concentration was disconnected and laid near the patient, flooding the chest area with oxygen. APSF also notes that the American Heart Association Guidelines for CPR specify that rescuers should try to ensure that defibrillation is not attempted in an oxygen-enriched atmosphere. APSF notes the pros and cons of disconnecting the patient from a ventilator before defibrillation. It concludes that leaving the patient connected to a ventilator during defibrillation can be done safely if exhaled gases and other sources of oxygen are vented away from the patient. However, it goes on to note there is a small risk of a sudden, acute increase in peak airway pressure and possibly barotrauma if the ventilator should cycle during the shock, but the risk of barotrauma should be mitigated by the high pressure limit features of the ventilator. If the patient is left connected, the ventilator should likely be paused. It cautions that, if the ventilator is paused, a person should be assigned to only operate the ventilator and restart ventilation after defibrillation. It emphasizes the risk of not remembering to turn the ventilator back on after defibrillation.

The **heat source** is obviously related to the defibrillation equipment, but how? Some reports talk about defective equipment, but defective technique is more likely. Arcing can occur as a result of poor contact of the gel defibrillation pads with the patient's skin. Potential causes of poor contact with the patient include: an insufficient or excessive amount of conductive gel, use of the wrong gel (e.g., ultrasound gel), application of paddles over irregular surfaces (e.g., bony prominences, wires, ECG electrodes), or misapplication of paddles (e.g., the metal surface of the paddle not completely on the pad, a fold in the pad, a pad smaller than the paddle's metal surface, a dry pad) (Health Devices 1994; 23: 307-309). When the pad or paddle is placed improperly, such as the pad not fully in contact with the skin, or the paddle placed on a bony prominence, an electric arc can occur during the discharge. The APSF review states that one way to potentially improve patient contact with gel pads, used by some Emergency Department physicians, is to place a pad then rip it off. This will remove the body hair and allow a second gel pad to be placed in good contact with the skin.

The **fuel source** can be almost anything. Common fuels in these scenarios are alcohol preps or vapors, bed linens, clothing, drapes, plastic tubing, and body hair.

We hope that TriStar Centennial Medical Center, where the current tragedy occurred, will make publicly available the results of their incident review and root cause analysis. That

way, the lessons learned can help avert similar tragedies not only at their facility but at any facility.

Defibrillator-related fires are a danger not only to the patient, but also to staff and potentially other patients and visitors. In the 2019 case (Wright 2019) it was noted that the entire 10th floor was so full of thick smoke that staff could barely see. In the North Carolina case (WRAL 2012) several staff were also injured and several patients had to be transferred to an ICU because of smoke inhalation. In the case reported in the ASA Monitor (ASA 2020), five staff members were treated in the ED for smoke inhalation, one RN suffered second-degree burns to the arm, and staff involved in the case were emotionally traumatized.

Also, in our October 2022 What's New in the Patient Safety World column "Portable Oxygen and Ambulance Fire" we described a fatal **explosion and fire in an ambulance** when a patient was being switched to a portable oxygen source. We noted that the back compartment of an ambulance could have a high concentration of oxygen and any sort of spark could trigger such an event. We mentioned defibrillator paddles as one potential source for such a spark.

So, fires triggered by defibrillators do occur. This case is a stark reminder of dangers to both patients and staff. While use of defibrillators is usually undertaken in emergency situations (though the same would apply to elective cardioversion), it is imperative that care is taken to ensure there is no free flow of oxygen near the patient.

We teach our staffs in hospitals and ambulatory surgery centers about the risks of surgical fires but how many of you teach your staffs about the risks of fires during defibrillation or cardioversion? It's easy to see from many of the above cases that, during a code situation, staff may forget to minimize the oxygen threat. You should probably include some cases in your simulation training for your code teams in which such potential oxygen threats are present.

The ASA Monitor article (ASA 2020) recommends preventative strategies that should be reviewed with code team members:

- Review the "Fire Triad": oxidizer, igniter, fuel
- Remove nearby fuels (clothing, linens, towels) prior to defibrillation
- Prevent arcing by ensuring good contact of defibrillation pads with the patient
- Prevent creating an oxygen-rich environment
  – Remove all sources of oxygen (>1 meter)
  – Do *NOT* disconnect Ambu®-bag from ETT during shock
  – If disconnected, remove Ambu®-bag >1 meter away
  – Direct bag reservoir away from the patient's body
- "All clear" check should include free flow O2 and pad contact.

Our prior columns on iatrogenic burns:

- March 2009 "Risk of Burns during MRI Scans from Transdermal Drug Patches"
- June 1, 2010 "Iatrogenic Burns"
- October 5, 2010 "More Iatrogenic Burns"
- December 23, 2014 "Iatrogenic Burns in the News Again"
- March 2015 "Another Source of Iatrogenic Burns"
- September 5, 2017 "Another Iatrogenic Burn"
- June 5, 2018 "Pennsylvania Patient Safety Authority on Iatrogenic Burns"
- July 28, 2020 "Electrosurgical Safety"
- January 2021 "New MRI Risk: Face Masks"
- May 3, 2022 "Iatrogenic Burns Again"

Our prior columns on surgical fires:

- December 4, 2007 "Surgical Fires"
- April 29, 2008 "ASA Practice Advisory on Operating Room Fires"
- November 2009 "ECRI: Update to Surgical Fire Prevention"
- January 2011 "Surgical Fires Not Just in High-Risk Cases"
- March 2011 "APSF Fire Safety Video"
- November 2011 "FDA Initiative on Preventing Surgical Fires"
- December 13, 2011 "Surgical Fires Again"
- April 24, 2012 "Fire Hazard of Skin Preps Oxygen"
- April 2013 "Reminder: Hand Sanitizers Are Flammable"
- June 25, 2013 "Update on Surgical Fires"
- October 1, 2013 "Fuels and Oxygen in OR Fires"
- August 12, 2014 "Surgical Fires Back in the News"
- December 16, 2014 "More on Each Element of the Surgical Fire Triad"
- December 2015 "Unique Ignition Sources in Surgical/OR Fires"
- January 10, 2017 "The 26-ml Applicator Strikes Again!"
- January 9, 2018 "More on Fire Risk from Surgical Preps"
- June 2018 "ISMP on Fire Risk from Skin Preps"
- July 2018 "FDA on Surgical Fires"
- September 11, 2018 "Lessons from a Surgical Fire"
- May 7, 2019 "Simulation Training for OR Fires"
- July 2019 "Surgical Fire – A New Risk Factor"
- July 28, 2020 "Electrosurgical Safety"
- July 2021 "Unique Way to Rapidly Identify Oxygen Flow"
- November 30, 2021 "Fire in the OR"

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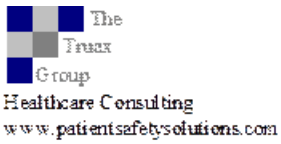

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