**BRIEF LABORATORY REPORT: SURGICAL DRAPE FLAMMABILITY**

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Fires in the operating room continue to present a hazard to patients, at times with catastrophic and debilitating results. Recent data from closed claim files reveal oxygen, electrosurgical unit (ESU), and surgical drapes are common components of the fire triangle in the operating room. In this era of biotechnological sophistication, why are surgical drapes flammable?

The purpose of this study was to test the flammability of different surgical drape materials and to determine the time to ignition using a bipolar ESU device in 21%, 35%, and 100% oxygen concentrations. Results show that regardless of oxygen concentration surgical drapes, when exposed to close contact with the ESU, are flammable. Time to ignition decreases with increasing concentrations of oxygen as expected. One of the surgical drapes tested was advertised to the hospital as nonflammable. Future research should focus on surgical drape materials and aim to reduce the flammability of such items in the operating room.

**Key words:** Electrosurgical unit, flammability, operating room, surgical drapes.

Despite medical advances and the abandonment of flammable anesthetic agents, operating room fires continue to occur at an alarming rate. In an analysis of 7 recent closed claim cases of operating room fires obtained from the American Association of Nurse Anesthetists, all shared the same components of the fire triangle. Oxygen in various concentrations served as the oxidizer, electrosurgical units (ESU) served as the ignition source, and the surgical drape served as the fuel source for the fire. The average payout for the Certified Registered Nurse Anesthetist in these cases was $25,997.00. In another closed claim study, ESU fires and burns accounted for 33% of burns sustained in the operating room.1

A study has been done that tested surgical drape flammability in various concentrations of oxygen using a laser as the ignition source.2 This study found that time to ignition decreased with increasing concentrations of oxygen and suggested manufacturers of surgical drapes should provide relevant flammability data on their products. In light of the most recent closed claim files for operating room fires it seemed necessary to test surgical drape flammability in a similar model using an ESU. In this era of biomedical sophistication it is surprising to find that surgical drapes used in the operating room are flammable.

**Purpose**

The purpose of this study was to test the flammability of different surgical drape materials and to determine the time to ignition using a bipolar ESU device in 21%, 35%, and 100% oxygen concentrations.

**Method and equipment**

The experiment took place in a laboratory setting under a high flow hood to simulate conditions in the operating room. An aluminum box with a partially occluding lid was used to house the experiment. Plastic oxygen tubing connected to an oxygen cylinder was placed under the partially occluded lid so that reproducible concentrations of oxygen were achieved. An oxygen analyzer, calibrated to 21% and 100% oxygen, was placed within 1 inch of where the ESU was being used. A bipolar electrocautery unit was used at a setting of 90 throughout the experiment. A tweezer tip was used with the 2 tongs 1 quarter inch apart (Figure 1). An orange, to simulate biological material, placed inside the box next to the oxygen analyzer, was cauterized with the surgical drape lying over the area being cauterized (Figure 2). This was accomplished by attaching the drape between 2 nuts on a screw mounted in the box next to the orange. Current, via the bipolar ESU tip, was applied to the orange and time to initial drape ignition was measured at 21%, 35%, and 100% oxygen concentrations, using a stopwatch. The brands of surgical drapes used were Cardinal Health (McGaw Park, Ill), 2 samples (one advertised as nonflammable) from Kimberly Clark (Roswell, Ga), and Medline (Mundelein, Ill). Each sample consisted of an approximately 3-inch by 3-inch swatch of a standard surgical 3-quarter length drape from a newly opened package.

**Results**

None of the surgical drapes would ignite with bipolar ESU applied directly to the drape, even in the pres-
ence of 100% oxygen concentrations. This was an expected finding because the drape materials are non-conductive. However, when placed in close proximity to the ESU being discharged on the orange, all 4 drape materials did ignite in all concentrations of oxygen including room air (Figure 3). Time to ignition decreased with increasing oxygen concentrations as expected (Table).

Discussion

In the original experimental design, a pencil tip ESU device was used; however, there was an inability to adequately attach a return plate to the ESU device. For this reason the bipolar ESU was used.

A major purpose of this experiment was to determine if differing oxygen concentrations would significantly affect drape material time to ignition. The results of this experiment found that the oxygen concentration had a less than expected effect on time to ignition and that all drape materials would ignite when placed next to the site of cautery. All drape manufacturers were contacted to obtain information regarding the composition of drape materials. Only Medline revealed that the drape was comprised of wood pulp and polyester, but the percentages of each ingredient was not provided. One of the companies advertised to the hospital that its drape was not flammable, but this study showed that the drape was equivalent in flammability potential when compared with the other drape materials. It is interesting that none of the drapes had any information regarding flammability printed on the packaging.

New research shows the danger and risk of burn injury particularly during surgery involving the head and neck during monitored anesthesia care. In all of the cases reviewed, the ESU was the ignition source, and supplemental oxygen was used at varying flow rates. Surgical drapes were the source of fuel in 81% of the cases studied.

While most studies begin with a question and end with an answer, this study began with an objective (to test drape flammability) and ended with a question: In this era of biotechnological sophistication, why are surgical drapes flammable?
Table. Time to ignition for the surgical drapes tested in varying oxygen concentrations

<table>
<thead>
<tr>
<th>Drape company</th>
<th>21% Oxygen</th>
<th>35% Oxygen</th>
<th>100% Oxygen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. tested</td>
<td>TTI in seconds (mean ± SD)</td>
<td>No. tested</td>
</tr>
<tr>
<td>Kimberly-Clark standard drape</td>
<td>5</td>
<td>7.47 ± 1.38</td>
<td>5</td>
</tr>
<tr>
<td>Kimberly-Clark drape advertised as nonflammable</td>
<td>5</td>
<td>7.44 ± 1.5</td>
<td>5</td>
</tr>
<tr>
<td>Medline</td>
<td>5</td>
<td>7.41 ± 1.35</td>
<td>5</td>
</tr>
<tr>
<td>Cardinal Health</td>
<td>5</td>
<td>7.35 ± 1.45</td>
<td>5</td>
</tr>
</tbody>
</table>

TTI indicates time to ignition.

REFERENCES

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