How Hazardous is Surgical Smoke?

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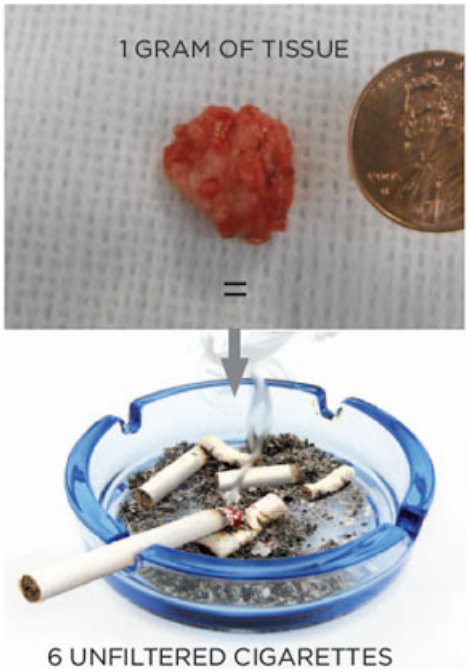
Have you ever wondered why your hospital mandates the removal of laser plume but not the smoke created by electrosurgery? Is electrosurgical smoke less hazardous? Research by Dr. Tomita and his colleagues note that when electrosurgery is used to vaporize one gram of tissue, inhaling the resulting plume would be like smoking six unfiltered cigarettes, while using a laser would be like smoking three unfiltered cigarettes (Tomita et al., 1989). So, why then are we still breathing in all of the toxins found in electrosurgical smoke when laser plume continues to be diligently evacuated? Could it be that the health of surgical team members isn't very important today?

When the laser was introduced in the mid 1980's, it was considered an amazing and fascinating surgical tool. However, surgical team members noticed the ever-present surgical smoke not only visibly obscured the surgical field, but also created an offensive odor that was harmful to the team's health. Even though the surgery team had been exposed to electrosurgery smoke for years, this new laser technology also created new concern regarding the toxins in surgical smoke, so much so that when a laser was used, a smoke evacuator was also employed. They went hand in hand.



Interestingly, electrosurgical smoke has never been held to the same standard. Is this because electrosurgical smoke is less harmful? Not according to ERCI which made the following correlation between laser and ESU smoke in a 2008 AORN Journal article by Brenda C. Ulmer, RN. "Lasers and ESUs both work by using high thermal energy and both release cell contents. When the particulate matter of both laser and electrosurgical smoke are compared, they appear to be very similar. Because of the similarities, facility policies on smoke evacuation should be the same for ESU as they are for lasers" (p. 723). Unfortunately, few medical facilities acted on this recommendation and electrosurgical smoke remains highly unmanaged, leaving healthcare workers largely exposed to this hazard.

The first smoke evacuators (built and patented by Wyman Stackhouse) were large, loud, and difficult to incorporate into the surgical procedure. Very quickly, these original devices were refined, re-engineered, and became the foundation of an industry dedicated to creating clean air in the operating room. A renewed interest in workplace safety led industry to design smoke evacuation devices into more user-friendly and effective models. Today we no longer need suction devices (designed to evacuate fluids) to rid the air of surgical smoke. Smoke evacuator units are now available for every surgical suite for the efficient removal of surgical smoke. The biggest challenge today is compliance in using these tools to remove the airborne hazards.

The first and probably most offensive hazard of surgical smoke is often thought to be the smell of surgical smoke. In reality, while the smell is foul, the real threat is what is in the toxins that cause the odor you smell in surgical smoke. These toxins are released into the air when the tissue (and the toxic gases they contain) is vaporized with energy devices. Experts estimate that there may be over 600 more compounds and gases in surgical smoke that have yet to be identified (Hoglan, 1995). Some of these toxic gases have already been shown to be carcinogenic, such as benzene, which also has been documented to be a trigger for leukemia (Ulmer, 2008). Even though these toxins exist in trace amounts, the surgical team inhales them repeatedly so cumulative exposure may become a problem (Ball, 2010b). Familiar toxins often found in surgical smoke include: acrolein, formaldehyde, polycyclic aromatic hydrocarbons, and carbon monoxide, just to name a few (Hensman et al., 1998).

Another hazard is the size of the particles within the smoke plume. Dr. Mihashi and others conducted classic research in 1981 that noted 77% of the particles in surgical smoke are 1.1 microns in size and smaller, just the right size to end up in the alveoli of the surgical team members' lungs where the critical exchange of gases take place. Dr. Baggish and others, in 1988, demonstrated conclusively that these small particles can lead to hypoxia and pulmonary congestion with bronchial hyperplasia and hypertrophy. Even though these studies are older, they still are pertinent today as they note the true hazards of surgical smoke contaminants. A standard surgical mask does not protect the wearer from smoke particles less than five microns in diameter. Recommendations call for appropriate smoke evacuation devices as the first line of defense to remove the plume from the air.

Some of the "really" nasty viruses that can be present in the air are extremely small. Listed below are a few viruses and a bacteria bacilli that are easily inhaled since they are well below the five micron size limits that a standard mask protects against.

Virus & Bacteria Types	Microns
HIV	0.15
Human Papillomavirus	0.45
Hepatitis B	0.045
Hepatitis C	0.040
TB	0.5

The potential for transmission of viable organisms within surgical smoke continues to be a debated issue even though research and anecdotal reports demonstrate that plume can transmit disease-forming organisms (Ball, 2010a; Barrett & Garber, 2004; Garden et al., 2002; Hallmo & Naess, 1991; Sawchuk et. al, 1989).

Surgical smoke has been deemed a workplace safety hazard but when plume is created during endoscopy, such as laparoscopy, then the hazard becomes a patient safety issue. In 1997, Dr. Ott and his colleagues conducted research that notes when plume is not evacuated appropriately during laparoscopic procedures, many patients present with nausea or headaches in the post anesthesia care unit. When patient blood tests are run, findings reveal elevated levels of methemoglobin and carboxyhemoglobin that decrease the oxygen-carrying capabilities of the red blood cells and thus cause the symptoms of nausea and headaches. When surgical smoke is evacuated during a laparoscopic procedure, elevated levels of methemoglobin and carboxyhemoglobin are not found. Surgical smoke evacuation is vital during endoscopic procedures too.

The hazards of surgical smoke have become a major concern for perioperative team members as the negative consequences of inhalation are revealed. Each year over 500,000 healthcare providers are exposed to the hazards of surgical smoke, making this a critical concern for workplace safety (Barrett & Garber, 2004). Surgeons usually do not experience the same level of exposure as the surgical team members (perioperative nurses, techs, anesthesia providers) who are in the operating room environment on a more regular basis. Research notes that long time exposure to fine particulate air pollution is associated with an increased incidence of cardiovascular disease and death among postmenopausal women (Miller et al., 2007). With many perioperative nurses within this postmenopausal age range, the alarm for the hazards of surgical smoke inhalation is heightened.

Within our surgical suites, this quest for clean air is in response to the outcomes of the many research studies that demonstrate the hazards associated with the inhalation of plume. If smoke evacuation practices are not employed in the OR, then the surgical team is exposed to the hazards of inhaling surgical smoke (Ball, 2004; Ball, 2010b). Not only have complaints of burning or watery eyes, headache, nausea, and respiratory problems been noted but research shows an increased incidence of asthma and other respiratory problems in the experienced perioperative nurse population (Ball, 2010a).

So why all of this flurry of activity to clear the air? In general, the quest for clean air has been an environmental goal for decades. The headline, "Cleaner air linked to longer lives" appeared in a newspaper on January 22, 2009, that highlighted reductions in particulate air pollution in the 1980's and 1990's have resulted in an average of five months increased life expectancy in 51 different metropolitan areas (Maugh, 2009). This, in turn, heightened the argument and need for stricter air quality management activities to achieve good health.

Industry has worked attentively to answer the call for effective and efficient smoke evacuation devices and supplies. These products are available today, so why are they NOT being used routinely as shown in research by Ball (2010a), and Edwards & Reiman (2008 & 2012)? This is a question that will tenaciously haunt many perioperative professionals until these hazards and their negative consequences are fully comprehended. Until then, we must be diligent in trying to incorporate smoke evacuation compliance as a standard practice. Otherwise, our surgical environments will continue to generate polluted air that will continue to negatively affect healthcare care providers.

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