Editorial

Surgical smoke and occupational health

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Surgical smoke

Surgical smoke is generated when using electrocautery, lasers and ultrasonic devices that cuts and coagulates various tissues and are used during surgical procedures. This smoke is formed by incomplete cauterization of tissues and contains toxic gases that can accumulate in the form of living or dead organic material (1), causing harmful effects to the health of those who inhale it. Statistical data suggest that each year in the United States around 500,000 professionals, including surgeons, nurses, and anesthesiologists, are exposed to surgical smoke hazards in operating rooms and such exposures cumulate over their lifetimes (2). In Taiwan, for example, more than 10,000 nurses are exposed to these hazards each year (3). Also, if a large amount of surgical smoke is present in the environment, it can obstruct the surgeon's view and make surgery last longer (4,5). Since the 1960s, the dangers of exposure to surgical smoke constituents and their presence of bioaerosols have been investigated (4).

The surgical smoke can be seen and its malodorous odor felt by operating room professionals, being composed of 95% of water vapor and 5% of combustion byproducts and cellular residues (6,7), such as chemical compounds like benzene, and biological materials such as blood particles, tissue particles, viruses and bacteria that have mutagenic and cytotoxic agents in aerosols (6,7). It is important to point out that different tissues can change the composition of surgical smoke and the compounds like acrolein, carbon monoxide, formaldehyde, hydrogen cyanide and methane are considered respiratory irritants, which make them dangerous for individuals working in the operating room environment. Some studies describe that 77% of these particles that form surgical smoke are smaller than 1.1 μm and are deposited in the bronchioles and alveoli (8,9).

The most commonly physical harm and symptoms in the scientific literature associated with surgical smoke exposure includes head and throat pain, coughing, eye tearing, eye irritation and mucosal diseases (1). In addition, most health professionals are unaware that exposure to surgical smoke can be equivalent to the consumption of 27 to 30 unfiltered cigarettes (10), and the biological effects of exposure to surgical smoke have been a cause for concern and discussion by several international institutions for directly interfering with the health of health professionals, being linked to the risk of developing chronic respiratory occupational diseases and cancer, in addition to interfering with patient safety.

Mitigate this risk

Several countries around the world have developed draft laws requiring hospital institutions to implement policies that prevent exposure to surgical smoke (2,11).

During the coronavirus disease 2019 (COVID-19) pandemic, perioperative teams and nurse leaders were faced with a new and unknown issue: the possible dangers found in surgical smoke when electrosurgery and laparoscopic devices were used in surgical procedures on COVID-19 patients in the operating room (4).

Currently, there is scientific evidence that the use of conventional surgical masks may not provide protection from exposure to surgical smoke (12). So, we asked ourselves: how to protect yourself from the harmful effects

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caused by exposure to surgical smoke?

The use of N95 masks, which are capable of filtering 95% of biological and mutagenic agents and cytotoxic components present in surgical smoke aerosols, is recommended, as in addition to providing protection to the worker, significantly reduces exposure to surgical smoke (12,13). Furthermore, we have the evacuation systems that will assist in the removal or capture of smoke, aerosols and odors generated in operating rooms during the use of electric scalpels. In addition, these systems will considerably reduce the presence of gaseous elements and smoke, provide a much cleaner surgical environment and provide greater visibility of the surgical site. Most of these evacuators are connected to filters that have activated carbon in their composition, which will absorb the chemicals that are present in surgical smoke (14,15).

New devices

Today we have an increased availability of products on the market that focus on minimizing these harmful effects caused by exposure to surgical smoke. The PlasmaBlade (PB), for example, was developed for this purpose. This device is known for working by delivering brief (40-µs range), high-frequency pulses of radiofrequency energy along the edge of a 12.5-µm-thin insulated electrode, using fewer energy to obtain a lower temperature while reducing the concentration of surgical smoke in the operating room (4,16).

In this context, a new surgical system named NTS-100, which applies low-temperature plasma, has been developed and a study by Zhang *et al.* aimed to analyze and compare the surgical smoke produced by the conventional high-frequency electrotome (ES), the PB, and the NTS-100 when electrosurgery were used. The models used were *in vitro* and *in vivo* porcine tissues (liver, muscle, skin, and subcutaneous tissues), because pig's genetic sequence simulate humans' (4).

In this study they could analyze and detect the volatile organic compounds (VOCs), which includes benzene, methane, and many others, and also estimate the accumulation and percentage of each part of those, the PM2.5 concentration (particulate matter), the mass of particles and the diameter distribution of these particles. These analyses are important as these compounds are known as carcinogens present in surgical smoke (4).

This is an important study to reconfirm the smoke hazard of the electrosurgery and surgical smoke. In this study, NTS-100 performed exceptionally well in the animal experiment and generated a lower concentration level of benzene in all experiments. In comparison to the smoke produced by the other devices, NTS-100 system had lower concentrations of VOCs and fewer aromatic chemical hazardous compounds were generated (4).

These results suggest that NTS-100 system can generate fewer types and lower concentrations of VOCs than did the PB. On the other hand, the VOCs types and concentrations generated by the PB and the NTS-100 had similar results in their *in vitro* analysis. Additionally, in the animal analysis, the results show that NTS-100 produced just ammonia oxides and methane when different tissues were cut, which could possibly be an outcome of the *in vivo* blood supply influence on the types and concentrations of VOCs. Therefore, it is assumed that the NTS-100 will have an effective clinic performance.

Overall, these results suggest the superiority of the NTS-100 and his effectiveness. So, it is essential to advance with research that expand the level of evidence on the subject and that assess the occupational risks of long-term exposure to surgical smoke.

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