Researchers identified over 40 chemical compounds in the urine of patients who had been exposed to laparoscopic surgical smoke. According to the analyses conducted, substantially higher concentrations of toluene and benzene were found in post-operative urine samples than in pre-operative ones.

Proper smoke evacuation during open and laparoscopic interventions protects the surgical team and the patient from complications that can arise due to smoke plume. The surgical team should employ the most effective methods for evacuation of surgical smoke. Periodic room ventilation alone does not constitute a suitable method for smoke evacuation.

Surgical smoke contains a mixture of harmful gaseous, vaporous and particulate substances whose composition differs depending on the procedure and type of application used as well as on the intervention itself. Surgical staff have reported considerable odor nuisance while performing their tasks. Exposure to surgical smoke can last from 2 to 12 hours, which, according to toxicological data, can pose serious health hazards.

Technically speaking, evacuation of surgical smoke gases at the source is the most sensible protective measure one can take. Mobile smoke evacuation systems, which have a suction volume capacity that can be over twenty times higher than that of wall units, should be used for this. DIN standard EN 60601-2-22 (addendum 1) recommends ULPA filters, which have a retention capacity of at least 99.999% for particles at least 0.1 μm in size.

For surgical teams and patients, toxic and biohazardous substances contained in surgical smoke pose a risk; these include toxic gaseous compounds (for ex. hydrogen cyanide, benzene), viruses, carcinogenic and malignant particles, cellular deposits, blood particles and bacteria.

During laparoscopic procedures, surgical smoke can impair the view of the surgical site and lengthen the duration of the intervention. Exposure of the patient to surgical smoke can lead to port-site metastases. Exposure to carbon monoxide can increase concentrations of carboxyhemoglobin and reduce the capacity of red blood cells to transport oxygen. The smoke can induce respiratory diseases and transmit viruses (for ex. human papilloma virus) and substances that the National Institute of Occupational Safety and Health (NIOSH) has classified as mutagenic and carcinogenic.

Therefore, guidelines and procedures recommend performing smoke evacuation using suitable systems so as to avoid such risks. Surgical face masks alone do not provide sufficient protection.
Electrosurgical procedures generate carbon oxides (CO and CO2), sulfur oxides and nitrogen oxides as well as ammonia, all of which can cause irritation of the respiratory tract and tissue hypoxia. Laser smoke has been proven able to breed viable bacteria such as Bacillus subtilis, Staphylococcus aureus, mycobacteria and Mycobacterium tuberculosis. Moreover, infectious viruses like HIV (human immunodeficiency virus), HBV (hepatitis B virus), BPV (bovine papilloma virus) and HPV (human papilloma virus) have been found in such smoke as well.

Surgical smoke can produce symptoms of acute intoxication in the form of headaches, weakness, nausea, muscle weakness and irritation of the eyes and the respiratory tract.

Nano smoke particles can be inhaled which penetrate into the bronchial tree, deposit there and cause cell damage. Such damage ranges from simple strain on the respiratory system through inert particles (for ex. titanium dioxide) and irritation of the respiratory tract (rhinitis, bronchitis) to malignant tumors (of the paranasal sinuses and bronchia). Some smoke particles can also enter the circulatory system, inducing toxic effects there. A total of 28 respondents (58.3%) of a study reported being disturbed by the smell of surgical smoke.

One of the key variables for preventing the spread of surgical smoke in the operating room is immediate evacuation of smoke emissions at their source. This measure prevents a large proportion of the vapors, gases and particles from entering into the respiratory tracts of the surgical staff in the first place.

In addition to chemical pollutants, surgical smoke contains biological particles (bacteria, viruses, fungi). Studies have shown that through evacuation 1 cm from the source, 98.6% of the smoke can be captured. Combining this with a high-filtration system (a HEPA filter) is advisable. Surgical masks do not provide sufficient protection.

Laser and electrosurgery smoke can contain infectious viruses like the human immunodeficiency virus (HIV), hepatitis B (HBV) and various strains of the human papilloma virus (HPV). Skin lesions with a high viral load pose a particular risk of transmission.

The properties and damaging effects of surgical smoke are shown. No study proves that surgical staff more often suffers from malignant tumours. In one study, viruses and bacteria could be detected in the smoke (more often with laser application than with electrosurgery). In another study, the mutagenic effect of the constituents of the smoke and in another malignant cell in the smoke could be determined. The complete risk for the OR-staff is unproven, but a danger is present. NIOSH and AORN recommend smoke extraction.

Although surgical smoke contains potentially hazardous substances, such as cellular material, blood fragments, microorganisms, toxic gases and vapors, many operating rooms (ORs) do not provide protection from exposure to it. Depending on its components, surgical smoke can increase the risk of acute and chronic pulmonary conditions, cause acute headaches; irritation and soreness of the eyes, nose and throat; dermatitis and colic. Transmission of infectious disease may occur if bacterial or viral fragments present in the smoke are inhaled. The presence of carcinogens in surgical smoke and their mutagenic effects are also of concern.

To reduce the hazards, surgical smoke should be removed by an evacuation system. Surgeons should assess the potential dangers of surgical smoke and encourage the use of evacuation devices to minimize potential health hazards to both themselves and other OR personnel.


Surgical smoke contains papilloma viruses as well as carcinogenic and mutagenic substances, 80% of which are nano particles (0.1µm) capable of penetrating the alveolar membrane. Constant exposure can lead to the development of Parkinson, Alzheimer, heart diseases, collagenosis and carcinoma. Thus, smoke evacuation has top priority.

The effectiveness of evacuation is influenced by distance to the source of the smoke, pump performance, hose diameter and smoke concentration. The author recommends evacuation using the monopolar electrode pencil for small amounts of smoke. Simple handling and cost-effectiveness promote the use of smoke evacuation systems.


One possible source of wound contamination is bacteria, aerosolized in electrosurgical smoke. This study used an experimental model with pig tissue to determine the extent of viable bacteria in surgical smoke. The results showed that only electrosurgery with strong hemostasis produces smoke with viable bacteria, but not laser or electrophotocoagulation contains viable bacteria. Furthermore, the study showed that smoke evacuation close to the electrosurgical source reduces the number of viable bacteria.

Therefore, suction can help to reduce wound contamination. Surgical nurses can advocate the use of smoke extraction systems as a way to protect patients from infection at the site of surgery.


Exposure to chemical compounds contained in electrosurgical smoke (ESS) is associated with an increased risk of carcinogenesis as well as lung and bone marrow damage. Even when customary precautionary measures are taken, infectious particles can be transmitted.

The hazards of electrosurgical smoke are well-known in most surgical specialist disciplines, including general surgery and dermatology. The authors have found hundreds of substances ranging from mere mucosa irritants to infectious bacteria and virus particles as well as carcinogens.

Orthopedic surgeons must be better-informed about the hazards posed by ESS. In regard to exposure and the long-term effects of ESS, further investigations are necessary.
Brandon and Young showed that without smoke evacuation, particle concentration can increase from a baseline of approximately 60,000 particles per cubic foot (cu/ft) to about one million particles per cu/ft within five minutes of activating the ESU (electrosurgical unit).

A study conducted by the University of Minnesota in Minneapolis measured carbon monoxide levels in the abdomen during cholecystectomies. The study showed that five minutes after use of electrosurgery, carbon monoxide was present in the abdomen at a median concentration of 345 ppm (parts per million). By the end of the procedure, the median concentration had risen to 475 ppm.

Elimination of surgical smoke can help minimize healthcare costs and improve the health of surgical staff and patients. Hospitals that advertise a smoke-free working environment in the operating room could have an advantage when it comes to recruiting and retaining perioperative staff due to the increasing shortage of nurses. Controlling the risks can ultimately prove advantageous for staff and patients alike.


DNA hybridization of tissue of a laser surgeon with laryngeal papillomatosis revealed human papillomavirus DNA types 6 and 11. It turned out that in the past the surgeon treated patients with anogenital condylomas with laser, who are known to harbor the same virus types. These results indicate that the papillomas in this surgeon may have been caused by inhaled virus particles from laser surgical smoke.


A gynecological OR-nurse, who repeatedly performs electro-surgery and laser surgical excisions of anogenital condylomas, developed a relapsing and histologically proven laryngeal papillomatosis. The report of a virological institute confirmed a high probability of correlation between the occupational exposure and laryngeal papillomatosis, so it was accepted as an occupational disease.

If the protective measures are adhered to, the potential risk of infection for surgeons and OR staff is very little. The risk of exposure appears to be higher in gynecological intervention than in the ENT, since the tissue masses are larger and the laser smoke is open surgical procedure escapes more easily into the room air.
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