



► ERBE IES 2

# Arguments supporting the use of smoke plume evacuation systems

## 1. Bovie Smoke – a perilous plume

### Aim of the study

This article by P. McCormick describes some of the risks of exposure to Bovie smoke.

### Summary

Surgical plume produced by an electrosurgical unit (ESU) is similar to an infectious vector. It is a carcinogen and a mutagen and in some persons it provokes allergic and inflammatory responses.

### Conclusion

Evacuation of the surgical plume produced by an ESU close to its origin is most effective in preventing exposure to the plume and the associated risks.

P. W. McCormick, *Bovie Smoke – A Perilous Plume*, *AANS Neurosurgeon* 2008; 17:10-12. <http://www.aans.org>, article ID 51343

## 2. Chemical composition of smoke produced by high-frequency electrosurgery

### Aim of the study

This study quantifies toxic compounds in surgical smoke.

### Summary

Dissimilar types of tissue subjected to electrocautery yield different chromatographic profiles. The clinical samples obtained were analyzed in this study and volatile organic compounds (VOC) such as n-alkanes, aldehydes, n-alkenes as well as xylene, ethylbenzene and toluene were identified. Additional irritant or toxic compounds found were cyclohexanone, and perchloroethylene in minor amounts. The concentration of toluene appeared to be inversely related to the production of cyclohexanone. The presence of irritant, neurotoxic and carcinogenic compounds in electrosurgical smoke plume was demonstrated in this study. Cigarette smoke shows approximately the same content of the investigated compounds, and operating room personal and surgeons should be informed about the potentially serious occupational risk.

### Conclusion

The exposure to surgical smoke should be reduced by implementing protective measures such as smoke evacuation systems.

O. S. Al Sahaf, et al., *Chemical composition of smoke produced by high-frequency electrosurgery*, *Irish Journal of Medical Science*, 2007; 176:229-32

In a recent study Weston et al. approves the occurrence of VOC in urology. Additionally he found carbon monoxide which concentration is high enough to cause adverse side effects on the surgeon and the OR staff.

R. Weston et al., *Chemical Composition of Gases Surgeons Are Exposed to During Endoscopic Urological Resections* 2009; 74:1154-5

## 3. Analysis of surgical smoke produced by various energy-based instruments and effect on laparoscopic visibility

### Aim of the study

The smoke plume produced by various energy-based laparoscopic instruments and its effect on laparoscopic visibility was investigated.

### Summary

In this study the bipolar macro forceps, an ultrasonic-based instrument, a monopolar radiofrequency dissector, and the monopolar shears were compared with regard to electrosurgical smoke production. A chart shows the deviation, geometric mean size and concentration of the smoke plume in a comparison of the instruments analyzed. Two aerosolized particle distributions were created by each instrument. The lowest number of large particles is produced by bipolar energy, while both ultrasonic-based and bipolar instruments generate a comparatively small number of small particles. Electron microscopy scanning verified the difference to the monopolar radiofrequency dissectors and standard monopolar scissors, which both produced a large number of small and large particles.

### Conclusion

Small and large particle populations are the two distinct components of surgical smoke plume. While both ultrasonic-based and bipolar instruments create a surgical plume, this plume has the lowest negative impact on visibility among the instruments tested, while monopolar instruments have the greatest negative effect on visibility. Laparoscopic visibility is strongly influenced by small-particle concentrations.

K. J. Weld, et al., *Analysis of surgical smoke produced by various energy-based instruments and effect on laparoscopic visibility*, *Journal of Endourology*, March 2007; 21:347-51

## 4. The visualisation of surgical smoke produced by energy delivery devices: significance and effectiveness of evacuation systems

### Aim of the study

Various energy delivery instruments were imaged in different light backgrounds.

### Summary

Under standard light it was almost impossible to visualize surgical plume and aerosols. Nevertheless, by means of a special illumination method with a background stroboscopic light, smoke and aerosols could be strongly enhanced in terms of contrast. The difference between using a smoke evacuation system and a no smoke evacuation system was also tested on smoke plume produced by electrosurgery, an ultrasound dissector and a CO<sub>2</sub> laser. In addition to laparoscopy conditions, the special illumination method was also tested inside operating theater during mammoplasty procedures. The production of surgical plume by energy-based systems in a clinical situation was clearly proven and helped raise the awareness of OR personnel.

### Conclusion

In the authors' opinion the use of evacuating systems in the OR is a necessity.

*T. de Boorder, et al., The visualisation of surgical smoke produced by energy delivery devices: significance and effectiveness of evacuation systems, Proceedings of SPIE, 2007; Vol. 6440 64400R-1*

## 5. Reducing the danger of surgical smoke exposure to health care workers

### Summary

Compared to room suction systems, smoke evacuators can pull at a much higher rate. Room suction systems are intended mainly to capture liquids rather than gases or particulates. Users must install suitable filters when using the room suction system to capture electrosurgical plume. Additionally with room suction systems it has to be ensured that the line is cleaned and the proper disposal of the filters has to be guaranteed. In general control of plume generated by electrosurgical systems/procedures or non-endoscopic lasers is more effective using smoke evacuators rather than room suction systems.

*V. Dennis, Reducing the Danger of Surgical Smoke Exposure to Health Care Workers, Environment of Care® News September 2007; Volume 10, Issue 9*

## 6. Surgical smoke and infection control

### Aim of the study

The authors analyzed potential health risks associated with surgical smoke.

### Summary

Lungs can be irritated by surgical smoke and aerosols which may have almost the mutagenicity of cigarette plume. The risk is cumulative, and thus OR personnel, who are closer to the point of plume production, are correspondingly at higher risk.

### Conclusion

High-efficiency filtration masks/respirators and smoke evacuation systems can help prevent the transmission of hazardous substances.

*E. Alp, et al., Surgical smoke and infection control, Journal of Hospital Infection 2006; 62:1-5*

## 7. Surgical smoke and ultrafine particles

### Aim of the study

The particle concentrations in "surgical smoke" during different surgical procedures were compared.

### Summary

Surgical smoke consisting of accumulation mode and ultrafine particles is generated by procedures such as laser tissue ablation, ultrasonic-based tissue dissection and electrocautery. Such particulate air pollution can result in adverse respiratory and cardiovascular health effects, as demonstrated by toxicological and epidemiological studies.

High concentrations of particles (>100.000/cm<sup>3</sup>) thicknesses between 10 nm and 1 µm are produced by argon plasma tissue coagulation and electrocautery. The highest concentrations were found to occur in close proximity to the location where the surgical smoke was generated.

### Conclusion

Using an air conditioning system the concentration of ultrafine particles rate could be reduced in a matter of seconds.

*I. Brüske-Hohlfeld, et al., Surgical smoke and ultrafine particles, Journal of Occupational Medicine and Toxicology 2008; 3:31*

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