



**EORNA**  
EUROPEAN OPERATING ROOM  
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# 9th EORNA Congress

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# “ON THE MOVE”

9th EORNA Congress

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# Surgical Smoke Evacuation: How to accomplish a surgical smoke free work environment

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**"ON THE MOVE"**  
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# Introduction

- What is surgical smoke, plume?
- Surgical smoke in the OR, what to do?
- How do we accomplish a smoke free work environment, is that possible?
  - Tool Kit
  - Local recommendations

# Do you recognize the signs?



DOHÁNYZÁSRA KIJELÖLT HELY

SMOKING AREA  
ZONE FUMER  
RAUCHSTELLE  
MESTO JUNE KIVONATA  
A dohányzásról lemondásért segítségért kérjük, látogasson el az alábbi helyszínre:  
02 92 200 892  
www.abnhs.com.nhs.uk



TILOS A DOHÁNYZÁS

NO SMOKING  
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RAUCHEN VERBODEN  
EVIJENE SAKKIVONATA  
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www.abnhs.com.nhs.uk

Basildon and Thurrock University Hospitals **NHS**  
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**This is a Smoke Free Hospital**

Smoking Is Not Allowed In The  
Grounds Or Buildings  
Thank you for your co-operation



**Geelieve niet  
to roken  
No smoking**



**No Smoking**

**NO SMOKING**  
It is against the  
law to smoke in  
this hospital

**No Smoking**

SMK grounds and facilities  
are smoke free. Please put out and  
properly dispose of smoking material.



Colchester Hospital University **NHS**  
1983 Foundation Trust

**A breath  
of fresh air...**



Smoking of tobacco products  
will not be allowed in  
our hospital or our grounds.

Vaping, using e-cigarettes,  
will be allowed only in designated  
places in our hospital's grounds.

Thank you for your cooperation.

If you would like help  
to give up smoking, visit  
[www.nhs.uk/smokefree](http://www.nhs.uk/smokefree)  
for free support

**SMOKEFREE**

## Surgical Smoke plume: What we know

- Surgical smoke plume and aerosols, is the vaporization of substances such as tissue, fluid, blood, into a gaseous form.
- 95% of surgical plume is water vapor (acts as carrier).
- The remainder is particulate matter, chemicals and biological material.
- Particles can range in size from 0.01 microns ( $\mu\text{m}$ ) to  $>200\mu\text{m}$ .
- Mean size is  $1.1\mu\text{m}$ .
- Particles of  $0.3\mu\text{m}$  can enter the alveoli of the lungs.
- Alveoli lack the defenses of the upper respiratory tract.

# Hazards of Surgical Smoke

There are three types of hazards

- Physical
- Chemical
- Biological



# Physical Hazards

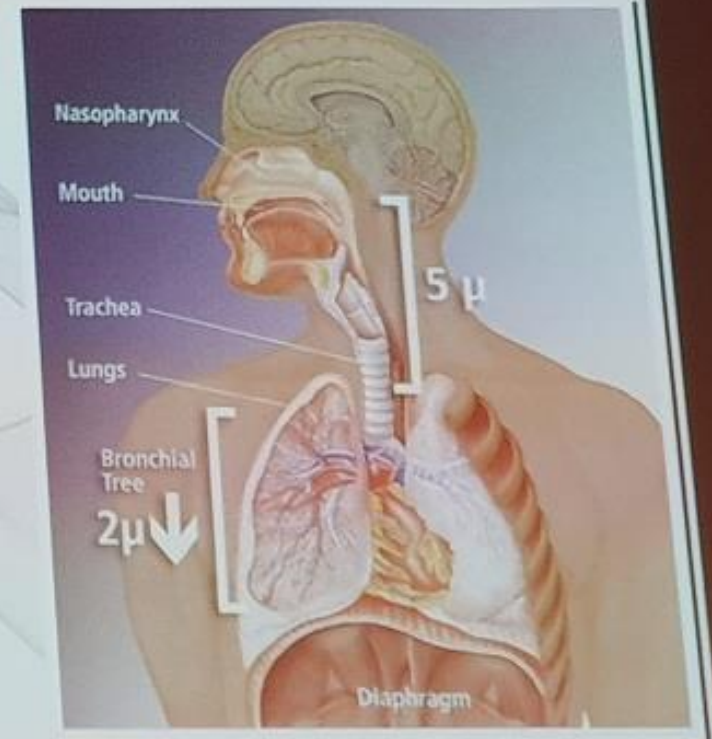
How far can the particles travel?

- 77% of surgical smoke is less than 1.1 microns \*)
- Particles of  $< 0.3\mu\text{m}$  can reach Alveoli

(Human hair	= $200\mu\text{m}$ )
• Bacteria	= $0.1 - 15\mu\text{m}$
• Viruses	= $0.01 - 0.3\mu\text{m}$
• HIV	= $0.15\mu\text{m}$
• Human Pappillomavirus	= $0.055\mu\text{m}$
• Hepatitis B	= $0.042\mu\text{m}$

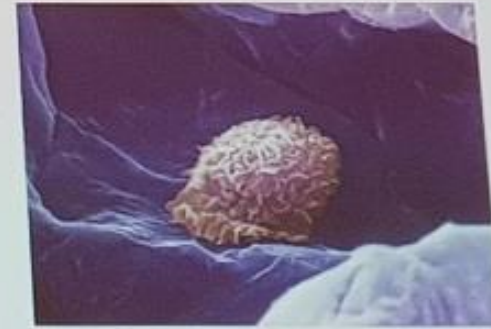
***The smaller the particle the further it can travel!***

\*) Mihashi et al, 1975

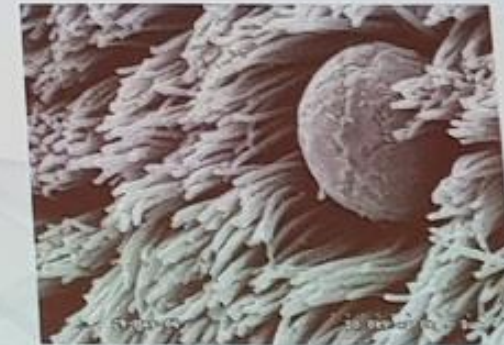


# Physical Hazards

- Should these particles reach the alveoli, negative health effects can occur:
  - Pneumonia (lung disease)
  - Bronchiolitis (inflammation of bronchioles)
  - Emphysema (long-term lung disease)
  - COPD (Chronic obstructive pulmonary disease)
  - Asthma



Alveolar macrophage



Smoke particle captured by cilia  
in the respiratory system



# Chemical Hazards

- Surgical plume contains over **40** hazardous chemicals. These are toxic, mutagenic and carcinogenic.
- **Benzene**: solvent used for petroleum distillates
- **Hydrogen Cyanide**: used in chemical warfare
- **Toluene**: used in paint thinner
- **Formaldehyde**: used in mortuaries for preservation
- **Ethylbenzene**: used in the manufacture of styrene
- **Perchloroethylene**: used as dry cleaning fluid
- **Carbon Monoxide**: hazardous by-product of combustion

*If you can smell it, it is present!*



# Biological Hazards

- As stated earlier, surgical plume is comprised of **95% water vapor**.

Water is a carrier of viable bacteria and viruses.

- Intact, viable HPV, HIV and HBV have been recovered in smoke plume.
- Intact strands of viral and human DNA have been recovered from smoke plume.
- Intact cancer cells have been recovered from smoke plume.
- Transfer of disease is possible and has been documented.<sup>11</sup>

Human Papilloma Virus



HIV



Hepatitis B Virus



# What about Laparoscopy (MIS)?

(Minimal Invasive Surgery)

- Surgical smoke plume during laparoscopic procedures is still smoke plume with the same hazardous components as during open surgery.
- Laparoscopic procedures are increasing.
- Surgeons visibility is obstructed by surgical smoke plume (re. UHD, 4k resolution monitors and even 3D).
- Often trocar valve is open to release surgical smoke - plume into the OR.
- New studies has proven, that not only OR staff are at risk of the exposure of surgical smoke/plume, but also the PATIENT is as risk.



# Health Hazards from Chemical Components

## Benzene and Toluene



- In Laparoscopic Cholecystectomy patients, **Benzene** was shown to be three times higher in the patients post operatively compared to pre operative levels.<sup>5</sup>
- Toluene levels were also noticeably higher though not as high as Benzene.
- Benzene diffuses across the placenta and is considered to be fetotoxic.
- Therefore, it appears that laparoscopic procedures in pregnant women may be subject to some risk.<sup>5</sup>

<sup>5</sup> *Chemical Composition of Surgical Smoke Formed in The Abdominal Cavity During Laparoscopic Cholecystectomy – Assessment of the Risk to the Patient International Journal of Occupational Medicine and Environmental Health*

CHEMICAL COMPOSITION OF SURGICAL SMOKE FORMED IN THE ABDOMINAL CAVITY DURING LAPAROSCOPIC CHOLECYSTECTOMY – ASSESSMENT OF THE RISK TO THE PATIENT

Journal of Occupational Medicine and Environmental Health  
Volume 10, Number 1, 2008  
Copyright © 2008 by Wolters Kluwer Health | Lippincott Williams & Wilkins  
DOI: 10.1097/JOM.0b013e31816b16b1

# Chemical Hazards

## *Endoscopic concerns*

The fourth concern involves the surgical smoke that is produced during endoscopic procedures (i.e., laparoscopy) and is not appropriately evacuated.

In 1993 Dr. Doug Ott and his team noted that when surgical plume is not evacuated during a laparoscopic procedure, there was an increase in the formation of methemoglobin and carboxyhemoglobin, which are modified forms of hemoglobin that cannot carry oxygen to the tissue. Therefore, tissue oxygenation suffers. **Patients in this study presented with nausea, vomiting, and/or headaches in response to this problem.** (Ott et al., 1993) For years when a patient exhibited these symptoms in the PACU, the anesthesia agents were blamed. This research showed that other conditions may be causing this problem. Dr. Ott also questions whether the presence of surgical smoke left during laparoscopy can cause a delay in tissue healing.

### Main symptoms of carbon monoxide poisoning:



Headaches



Nausea



Breathlessness



Dizziness



Collapse



Loss of consciousness

# Inhaling Surgical Smoke

- Using the **CO<sub>2</sub> laser** on one gram of tissue is like inhaling the smoke from **three cigarettes** in 15 minutes.
- Using **ESU** on one gram of tissue is like inhaling smoke from **six cigarettes** in 15 minutes.

*(Tomita et al., 1989)*

*Hill, D.S. et al. (2012) "On average the smoke produced daily was equivalent to 27-30 cigarettes"*



## Exposure can lead to....

- Nausea
- Sore Throat
- Congestion
- Shortness of Breath
- Bronchospasm
- Eye irritation
- Asthma / Allergy
- Headache / Dizziness
- Ocular Irritation
- Excessive Tiredness



Exposure can lead to....

*It is a fact that perioperative nurses have twice the incidence of many respiratory problems as compared to the general population (Kay Ball, PhD 2010).*





# Biological Hazards

## HPV positive tonsillar cancer in two laser surgeons: case reports

Margo Rioux<sup>1</sup>, Andrea Garland<sup>2\*</sup>, Duncan Webster<sup>2</sup> and Edward Reardon<sup>2</sup>

### Abstract

A 53 year-old male gynecologist presented with human papillomavirus (HPV) 16 positive tonsillar squamous cell carcinoma. He had no identifiable risk factors with the exception of long term occupational exposure to laser plumes, having performed laser ablations and loop electrosurgical excision procedures (LEEP) on greater than 3000 dysplastic cervical and vulvar lesions over 20 years of practice. The second patient is a 62 year old male gynecologist with a 30 year history of laser ablation and LEEP who subsequently developed HPV 16 positive base of tongue cancer. He also had very few other risk factors for oropharyngeal cancer or HPV infection. HPV is a probable causative agent for oropharyngeal squamous cell carcinoma and has been reported as being transmittable through laser plume. This paper suggests that HPV transmitted through laser plume can result in subsequent squamous cell carcinoma.

**Keywords:** Laser plume, Human Papillomavirus, Squamous cell carcinoma, Tonsillar cancer, Oropharyngeal cancer

*The 53 year-old gynecologist received worker's compensation due to the exposure of surgical smoke plume from his 20 years of practice.*

# How do we accomplish a smoke free environment?

From this →



← To this

# Tool Kit

- Contents in surgical smoke plume
- Risks and hazards
- Local recommendations
  - Action Card as a reminder for day-to-day
- Equipment knowledge
- Laws and regulations



## Local recommendations, Action Card

1. First choice for skin incision; Scalpel
2. Diathermy pencil should be activated 2-3 seconds before starting to cut
3. Cut slowly so the suction tube can evacuate as much smoke as possible
4. Surgical smoke must be evacuated within 2-3cm from the source
5. Do not remove the diathermy pencil before the smoke is visibly gone



# Equipment Knowledge

- Dedicated smoke evacuators
- Replacement filters (life)
- Diathermy pencils with integrated smoke evacuation
- Laparoscopic smoke evacuation solutions
- Inline filters

# We are protected by the law. Work environment Acts



- Denmark: A.1.1, A.1.7, A.1.9, C.1.3, D.5.4
- Norway: §3-2, §3-11, §4-1, §4-4, §4-5, §5- §7-1
- Sweden: Swedish Operating Room Nurses Association, **SEORNA**, published a recommendation of prevention of surgical smoke.
- UK: Control of Substance Hazardous to Health Regulations (COSHH - 2002)
- Hungary: Act no. 93, section 25, 32, 33, 38, **64**
- **EU Directive:** Legislation in Europe aims to minimize the health risks of biological agents at the workplace (European Parliament and Council Directive 2000/54 / EC)



## Arboportaal

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## Documenten

### Blootstelling rookgassen bij diathermie

Video | 01-01-2010

Bij het dichtschroeien of snijden van weefsel tijdens een operatie wordt gebruik gemaakt van diathermie-apparatuur waarbij chirurgische rook vrijkomt. Deze rook is mogelijk schadelijk voor de gezondheid van operatiepersoneel. D.m.v. directe afzuiging van de rook bij de bron worden de medewerkers niet blootgesteld. De lucht blijft schoon en de verbrandingsgeur blijft achterwege.

<https://www.arboportaal.nl/documenten/videos/2010/1/1/blootstelling-rookgassen-bij-diathermie>

# Recommendations

- There is basis for implementing a **guideline** for the use of electrocautery (diathermy) devices, with smoke evacuation systems:
  - On Surgical Smoke, Risks and Hazards
  - Laws and Regulations
  - Local Recommendations
  - Knowledge on Equipment
  - **EDUCATION!**





**Thank you  
for your attention**

