Surgical staff safety: going up in smoke?

A reader survey has shown that over two-thirds of respondents working in operating theatres are concerned about the effects of surgical smoke on their health, yet only 21% said that their theatres ‘always’ used smoke evacuation devices when performing electrosurgery or laser treatments. Should their use now become mandatory? Louise Frampton reports.

The Association for Perioperative Practice (AfPP) has continued to highlight the dangers of exposure to surgical smoke inhalation and is campaigning for improved protection of healthcare workers in the operating theatre environment. AfPP’s CEO, Dawn Stott has warned that perioperative professionals are still being routinely exposed to surgical smoke, plume and aerosols produced by instruments used for dissection and haemostasis, despite the mounting evidence of the harm this can cause.

Smoke plumes in the operating theatre
Tools to achieve haemostasis and dissection include electrosurgery units, lasers, ultrasonic devices, high-speed drills, burrs and saws. All of these devices produce heat, which allows the surgeon to achieve the desired tissue effect. The most common device used is the electrosurgery unit. Electrosurgery uses high-frequency current to cut and coagulate tissue. The disruption releases the cellular fluid as steam and spews the cell contents into the air forming surgical smoke plume.

Lasers are the second most common heat-producing device. Lasers produce high heat that boils and explodes the cells. This cellular vaporisation releases steam and cell contents. When the particulate matter of both laser and electrosurgical smoke are compared, they are very similar — as identified by the Emergency Care Research Institute. Therefore, facility policies on smoke evacuation should be the same for electrosurgery units and for lasers.

Potential for harm
Barrett and Garber identified a long list of chemicals present in surgical smoke. Two of the chemicals of concern were acrylonitrile and hydrogen cyanide. Acrylonitrile is a volatile, colourless chemical that can be absorbed through the skin and lungs. Acrylonitrile liberates hydrogen cyanide. Hydrogen cyanide is toxic, colourless and can also be absorbed into the lungs, through the skin and via the gastrointestinal tract.

Previous studies have also investigated the potential harm of surgical smoke. Among these is a study by Baggish et al, which studied the effects of laser smoke on the lungs of rats. The study found that the fine particulate matter resulting from tissue vaporisation was deposited in the animals’ alveoli, which produced congestive interstitial pneumonia, bronchiolitis, and emphysema.

Mandating the use of smoke evacuation devices and further education are required to ensure staff fully understand the risks, know how to protect themselves and have access the technologies to ensure a safe working environment.
In fact, Tomita et al have shown that the smoke issued from laser ablation of 1 gram of tissue is comparable to the burden derived from three cigarettes. For electrocautery, the number is six cigarettes.5

In addition to the emissions of harmful chemicals, evidence shows that surgical smoke can contain malignant cells, live bacteria and viruses, including HPV and the human immunodeficiency virus.6,7 Last year, a study by Lui et al reported that 80% of smoke plumes were found positive for HPV, from patients with HPV-positive cervical intraepithelial neoplasia, after undergoing a loop electrosurgical excisional procedure (LEEP).6

More recently, this year, Fox-Lewis et al published a systematic review on human papillomavirus and surgical smoke. The systematic literature search of Embase and Ovid-Medline identified 21 relevant articles. These demonstrated that surgical smoke from the treatment of HPV-related lesions can contain HPV DNA, and that this can contaminate the upper airways of operating theatre staff. The authors stated that whether this corresponds to infectious virus is not known.

They concluded that: “While HPV transmission to operating theatre staff from surgical smoke remains unproven, it would be safest to treat surgical smoke as potentially infectious. Necessary precautions should be taken when performing smoke-generating procedures, consisting of: local exhaust ventilation, general room ventilation and full personal protective equipment including a fit tested particulate respirator of at least N95 grade.” They added that there is currently insufficient evidence to recommend HPV vaccination for operating theatre staff.

The National Institute for Occupational Safety and Health, in the US, confirms a link between smoke plumes and cases of HPV in healthcare workers and warns that precautions should be taken.11 The Institute refers to a paper by Hallmo et al which outlines a possible case of transmission in a 44-year-old laser surgeon, who presented with laryngeal papillomatosis. In situ DNA hybridisation of tissue from these tumours revealed human papillomavirus DNA types 6 and 11.

Past history revealed that the surgeon had given laser therapy to patients with anogenital condylomas, which are known to harbour the same viral types. The authors concluded that the papillomas “may have been caused by inhaled virus particles present in the laser plume”.

Guidance

In the UK, the Health & Safety Executive states: “Where a risk assessment indicates, COSHH regulations may apply in the operating theatre environment, as some published reports conclude that hazardous substances can be associated with surgical smoke. Under such circumstances employer must comply with the COSHH regulations to control the exposure of their staff to these substances.”13

The British Occupational Hygiene Society (BOHS) guidance also acknowledges the harmful effects of surgical smoke and specifically recommends the use of smoke evacuation: “Theatres usually have high rates of general ventilation. This does not, however, prevent the emission of smoke into the room or the exposure of staff. Local exhaust ventilation (LEV) is required to achieve this. The known irritancy, the other hazardous properties of the component contaminants, and the persistent concerns of chronic effects combine to lead to the conclusion that effective LEV should be considered a required control measure.”14

In a device bulletin, published in 2008, the Medicines and Healthcare products Regulatory Agency also recommended that smoke evacuation systems should be used during laser surgery.15 In addition, it is worth noting that the European Parliament and Council Directive 2000/54 / EC (on the protection of workers from risks related to exposure to biological agents at work) also requires the employer to:

- Assess the risks posed by biological agents.
- Reduce the risk through: elimination or substitution, exposure prevention and control, provision of information, and training for workers.
- Provide health surveillance as appropriate.

Further to the above, numerous bodies have highlighted the need to protect healthcare workers from surgical smoke.
workers in the operating theatre environment from the harmful effects of smoke inhalation. The Association of Perioperative Registered Nurses (AORN), the International Federation of Perioperative Nurses (IFPN) and the AFPP have all stated that dedicated smoke evacuation machines should be used to evacuate surgical smoke.16-18

In 2018, the European Operating Room Nurses Association (EORNA) issued the following recommendations19 on prevention and protection of surgical plume:

- Ventilation in the OR should be at least 15-20 air changes/hour with positive pressure.
- When using medical technical devices that generate ultrafine particles, evacuation systems should be used during the whole time that the device is used.
- Personal protective equipment should be applied correctly and ensure staff are not exposed to ultrafine particles.
- Education on prevention and protection should be mandatory.

The guidance emphasises that face masks and respirators should be considered “the last line of defence”. It is important that staff are made aware that surgical masks are inadequate in filtering smoke particles or cellular components. In addition, leakage of the mask’s seal to the face poses another source of possible penetration.

One study found that: “Surgical masks do not provide measurable protection against surgical smoke. Surgical mask respirators offer considerably improved protection versus surgical masks, while the N100 filtering facepiece respirator showed significant improvement over the surgical mask respirators.”20

Despite the consensus opinion on the need for smoke evacuation in operating theatres, adoption varies across healthcare organisations and even between theatres within the same hospital. While many staff are concerned about the risks, not everyone appears to be informed or worried about the potential impact on their health.

A survey by Michaelis et al21 found that half of all surgeons assumed that there were high health hazards of surgical smoke without taking protective measures. Operating room nurses were more often concerned (88%). However, only a few felt properly informed about the topic. In total, 52% of hospital respondents reported any type of special suction system to capture surgical smoke.

The survey was carried out in German healthcare organisations, but are UK hospitals taking health and safety any more seriously? A survey of smoke extractor use in UK plastic surgery units, in 2012, revealed that only 66% of units had smoke evacuation devices available. The survey sample included readers from a variety of roles within the operating theatre – including surgeons, theatre managers, perioperative practitioners and operating department practitioners (ODPs). Over 69% of respondents were either ‘somewhat concerned’ or ‘very concerned’ about the potential effects of surgical smoke on their health.

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The Clinical Services Journal recently conducted a snapshot survey of theatre staff to establish whether this trend was still apparent in UK hospitals. The survey suggested there was significant room for improvement, but has there been any improvement since this study was first conducted?
Staff should be empowered to use smoke evacuation devices ‘some of the time’ (almost half), which is encouraging but there is clearly room for significant improvement. Of particular concern is the fact that nearly a fifth ‘never’ use smoke evacuation and a further 10% simply do not know whether or not devices are being used in their theatres to protect them from harmful smoke.

Staff were also asked how confident they were that they knew how to protect themselves from surgical smoke inhalation. Just under a fifth said they were ‘very confident’, while 40% were ‘somewhat confident’. But many were either ‘not at all confident’ or ‘not very confident’, suggesting a need for further education and training.

Our survey suggests there is still wide variation in practices across Trusts and even within hospitals, and staff are still being put at risk. In Denmark, legislation has been in place since 2001 to ensure surgical smoke is removed at the point of surgery. So, why is the UK still lagging behind? A lack of knowledge, hierarchical relationships in the operating room, a lack of legal obligation and cost are some of the reasons for slow adoption, cited by healthcare workers in other countries21 and these barriers are likely to remain.

Mandating the use of smoke evacuation devices and further education are required to ensure staff fully understand the risks, know how to protect themselves and have access to the technologies to ensure a safe working environment. Staff should be empowered to speak up – to protect themselves and their colleagues. Furthermore, the cost of smoke evacuation devices should not be a barrier; staff are a hospital’s most valuable asset and their safety must be made a priority. But the cost of litigation will also be much higher as awareness increases of the links to harm.

Commenting on CSJ’s latest survey findings, Lindsay Keeley, AIP Patient Safety and Quality Lead, said, “Under the Health and Safety at Work Act (1974) it is the duty of every employer to ensure, so far as is reasonably practicable that the health and safety of all employees is undertaken to reduce exposure from harmful substances. The Health and Safety Executive (HSE, 2012) have provided scientific evidence which corroborates that perioperative practitioners are increasingly being exposed to surgical smoke/plume and aerosols putting them at risk from ‘diathermy emissions’.”

“APPP will continue to pursue legislative changes to ensure that all operating theatres are fitted with surgical smoke/plume evacuation devices as standard practice in the UK.”

References

2. Emergency Care Research Institute, ESU smoke: should it be evacuated? Health Devices, 1990.