A case for the prevention and management of surgical fires in the UK

EXPERT WORKING GROUP RECOMMENDATIONS
September 2020

CONTENTS

INTRODUCTION

What is a surgical fire and why is urgent action needed?

This report contains important information on surgical fires and their prevention, to be submitted to the Centre for Perioperative Care (CPOC), in order to make the case for its inclusion on their agenda.

In the perioperative setting, a fire may cause injury to both the patient and healthcare professionals. Injuries caused by a surgical fire most commonly occur on the head, face, neck and upper chest. The prevention of surgical fires, which can occur on or in a patient while in the operating theatre, is an urgent and serious patient safety issue in UK hospitals.

There are **three elements in the fire triad** that must be present for a surgical fire to occur within the operating theatre:[1,2]

1. Ignition source – this includes electrosurgical units (also called surgical diathermy units), fibre optic light sources and lasers;
2. Fuel – this includes the patient (hair, gastrointestinal gases), alcohol-based skin prepping agents, swabs, patient gowns, aerosol adhesives and petroleum-based products; and
3. Oxidiser – this is where there is an oxygen enriched environment (>30%) and where nitrous oxide is present with the oxygen.

From 01 April 2009 to 31 March 2019, NHS Resolution[3] claim to have been notified of 631 clinical negligence claims relating to surgical burns to patients. Although surgical fires were a small minority of the claims mentioned, they can be costly. One surgical fire claim settlement mentioned resulted in NHS Resolution paying £125,000 in damages and legal costs.

Electrosurgical units (ESUs), lasers and fibre optic light sources are all well-described ignition sources for surgical fires. Common sources of 'fuel' in an operating theatre fire include drapes or towels, endotracheal tubes, swabs and alcohol preparation solutions that have not been allowed to evaporate fully and, as a consequence, have pooled on or under the patient. A fibre optic light cable can be an ignition source if it is disconnected from the working element and allowed to contact drapes, swabs or other fuel sources. If disconnected and left on the operative field, the end of the cable can emit sufficiently unfiltered light that can scorch drapes and potentially lead to ignition. The most common ignition source is the ESU, which contributes to 90% of surgical fires in the United States. The most common fuel source associated with surgical fires are surgical drapes, which contribute to 81% of surgical fires.

Surgical fires are recognised as an international patient safety concern. In the US between 1994 and 2013, the Food and Drug Administration (FDA) identified 294 injuries and fatalities as a result of a surgical fire.[4] A 2009 report estimated 550–650 such fires occur annually in the US,[5] and more recent reports estimate 88-105 incidents annually.[6] It has been estimated that the number of surgical fires has dropped by 44% since 2011, and 71% since 2004.[7] This reduction in the incidence of fires could be due to efforts to educate perioperative professionals about the risk factors of surgical fires and is an approach that the Short Life Working Group on Surgical Fires recommends the NHS to follow as a matter of urgency.

"Surgical drapes and cotton towel fires easily ignite when oxygen builds up beneath them during certain surgeries." (Photo credit Mark E. Bruley Consulting Investigator and Author, Medical Technology Accidents, Vice President Emeritus, Accident & Forensic Investigation, ECRI Institute. Photos reprinted with permission of ECRI. ©ECRI 2020.)

[1]Association of Perioperative Practitioners. Standards and Recommendations for Safe Perioperative Practice 2016, 4th ed Harrogate.
[2]Jones TS, Black IH, Robinson TN, Jones EL. Operating Room Fires. Anesthesiology 2019;130(3):492-501.
[3]NHS Resolution. Did you know? Preventing surgical burns. 2019. https://resolution.nhs.uk/wp-content/uploads/2019/10/Did-You-Know_Surgical-burns-Digital-Accessible-1.pdf
[4]Overbey DM, Townsend NT, Chapman BC. Surgical energy-based device injuries and fatalities reported to the Food and Drug Administration. Journal of the American College of Surgeons 2015; 221(1):197-205.
[5]Retzlaff K. Fighting fire with preparation. AORN Connections 2009 Oct.
[6]Bruley ME, Arnold TV, Finley E, Deutsch ES, Treadwell RT. Surgical fires: decreasing incidence relies on continued prevention efforts. PA Patient Safety Advisory 2018; 15(2). http://patientsafety.pa.gov/ADVISORIES/Pages/201806_SurgicalFires.aspx.
[7]Ibid, p. 1.

The establishment of the Short Life Working Group for the prevention of surgical fires

A Short Life Working Group (SLWG) for the prevention of surgical fires was established in May 2019, following an initial discussion in December 2018 on the issue of surgical fires in the UK. The group of experts from healthcare organisations and bodies across the UK convened four times in 2019 with the aim of compiling this document, in order to recommend surgical fires for a Never Event classification. The group conducted a literature review of best practice and evidence, in the UK and internationally, which informed the development of a number of considerations that could address the issue of surgical fires.

These considerations were:

- **Professional associations to explore the value of a national awareness campaign for healthcare professionals;**
- **Mandate the inclusion of surgical fire prevention into surgical and perioperative education and training syllabus;**
- **NHS England to explore how to evolve the procurement process of sanitising products, to reduce surgical fire risk and encourage procurement of proven surgical fire-safe technologies; and**
- **Ensure that the new NHS Patient Safety Alert System highlights the risks of surgical fires to the Health Service, and sets out clear and effective actions for providers to take on this safety critical issue.**

This report contains information surrounding the scale of the problem of surgical fires in the UK, in addition to reported experiences of these incidences by both healthcare professionals and patients. It also includes prevention and management materials, and mandatory training that should be consistently delivered to hospital staff, and concludes with recommendations moving forward, in order to ensure the prevention of surgical fires in UK hospitals.

The members of the SLWG include:

- **Dawn Stott:** Chief Executive Officer – The Association for Perioperative Practice (AfPP)
- **Lindsay Keeley:** BSc, RGN, Patient Safety & Quality Lead – AfPP
- **Kat Topley:** MSC, RGN, Non-Elected Trustee – AfPP
- **Dr Lesley Jordan:** Consultant Anaesthetist and Trust Medical Patient Safety Lead – Royal United Hospitals Bath NHSFT
- **Daniel Rodger:** Senior Lecturer, Operating Department Practice – London South Bank University & The College of Operating Department Practitioners
- **Bronagh Scott:** Interim Director of Nursing Policy and Practice – Royal College of Nursing
- **Archie Naughton:** Trustee – Patients' Association
- **Shivani Shah:** Head of Programmes, and Community and Patient Engagement Manager – Patients' Association
- **Helen Andrews:** Clinical Consultant – Becton Dickinson
- **Greg Quinn:** Director, Public Policy and Advocacy UKI – Becton Dickinson
- **James Tyrrell:** Senior Director & Chair, Global Healthcare – APCO Worldwide
- **Mohammed Habib:** Senior Associate Director, APCO Global Solutions – APCO Worldwide
- **Lottie Wistow:** Associate Consultant – APCO Worldwide

We would also like to extend our thanks and gratitude to **Mark Bruley**, forensic surgical fires investigation and prevention expert, for his support and advice during this process.

The administrative support for these meetings was provided by BD, who has no editorial control in the outputs of the group.

CONSEQUENCES AND IMPACT OF SURGICAL FIRES

The human cost of surgical fires is significant

There are numerous personal accounts of patients who have been harmed due to a surgical fire and, in nearly all of these cases, they were wholly avoidable: *'Ms. Holden, who was breathing through an oxygen mask during the procedure, says her face, head and neck all caught on fire, ultimately causing, among other things, pain, disfigurement, impaired vision, terror and loss of independence'*.[8] This was due to leaving an inadequate amount of time to let the alcohol-based skin prep dry before using an electrosurgical device. More recently, a patient undergoing surgery for pancreatic cancer caught fire and suffered 40% burns, and died a week later as a result of her injuries.[9]

Surgical fires often leave patients with long-lasting, life-changing injuries, including:

- Localised burns and subsequent infections to the parts of the body damaged by the fire;
- Inhalation injuries from inhaling flames or smoke;
- Difficulty breathing through their nose due to scar tissue build-up;
- Pain from multiple plastic surgeries;
- Difficulty chewing because of the lack of elasticity around the mouth and face; and
- Long-lasting physical and emotional scars.

Five categories of surgical-related burns can be observed:

- chemical ignition (i.e. a fire on the patient during surgery – the focus of this guidance);
- chemical related;
- diathermy related;
- equipment related; and
- other. These themes are identified through clinical review.

[8]Burger J. Million-Dollar Lawsuit Claims Surgical Fire Ruined 86-Year-Old Woman's Life. AORN Outpatient Surgery Magazine 2017. http://www.outpatientsurgery.net/outpatient-surgery-news-and-trends/surgical-malpractice/million-dollar-lawsuit-claims-surgical-fire-ruined-86-year-old-woman-s-life--01-11-17.
[9]BBC News. Cancer patient set on fire during operation in Romania. 2019. https://www.bbc.co.uk/news/world-europe-50947404.

Personal impact: Anthony Gold case study

London law firm, Anthony Gold, have showcased the impact surgical fires have on the patients who experience them, exemplified in the below case study.[10]

I recently settled a claim for a client who suffered a significant burn during an operation under general anaesthesia.

My client developed haemorrhoids during pregnancy. She was referred to a colorectal surgeon for an operation to remove both the haemorrhoids and a skin tag.

During the operation, the surgeon wiped down her skin with an alcohol based solution prior to using a diathermy handset. [Diathermy is a medical and surgical technique involving the production of heat in a part of the body by high-frequency electric currents to stimulate the circulation, relieve pain, destroy unhealthy tissue, or cause bleeding vessels to clot].

The alcohol based solution had apparently pooled underneath my client's body on the operating table. When the surgeon used the diathermy handset it produced a spark which set fire to the pooled fluid. The surgeon eventually realised and put out the flames with his hands but not before my client had suffered some serious burns.

The following day she was transferred to another hospital to be treated by a specialist plastic surgeon. She stayed in that hospital for a week. Her burns were treated and re-dressed daily. This was extremely painful for her and she needed a lot of pain medication including oral morphine. Eventually, she was transferred again, this time to a specialist burns hospital. Even after her discharge from the burns hospital she had to return weekly to the outpatients' clinic for a further two months.

Unsurprisingly, breach of duty was admitted by the National Health Service Litigation Authority (NHSLA) on behalf of the surgeon but my client was put to "strict proof" in relation to the harm his negligence had caused her.

I started by obtaining expert evidence from a specialist consultant burns specialist. As well as reporting on the scarring, the surgeon was concerned about her psychiatric reaction to what she had been through and to the scars she had been left with. He recommends that evidence is obtained from a consultant psychiatrist. He also recommended a referral to a specialist laser dermatologist for a consultation to see whether or not her scarring would benefit from some specialist treatment.

The consultant psychiatrist agreed with the burns specialist that my client had been affected by the incident and that she would benefit from some professional counselling. The dermatologist recommended a treatment plan using both bleaching cream and laser therapy to work on her scarring. The estimated cost of the dermatology treatment alone was around £10,000.

Despite having access to my client's medical records, the NHSLA made an offer to settle her claim before the medical evidence was complete. Their offer was for £1,500. Having taken my advice, she firmly rejected the offer and we continued to gather supporting evidence to show both the injury she had suffered and the further treatment she required.

There was a modest claim for care and assistance given to my client by her family during the time she was in the hospital. Before discharging her home, the burns specialists had shown her mother how to dress and clean her wounds. As well as having her burns re-dressed by her mother. She also had to travel to and from the many outpatient appointments for treatment of the burns during which time her family members looked after her small child. The travelling was very painful for my client.

When the medical evidence was complete my client instructed me to disclose the reports and details of her financial losses to the NHSLA with an offer to settle quite some way above the £1,500 previously offered.

Despite the evidence, the NHSLA still did not seem to appreciate the significance of my client's injuries and these had to be explained further. Nevertheless, after some discussions and negotiations, my client was pleased to accept a settlement that was more than 15 times the amount of the initial offer.

At the time when my client woke up from the anaesthesia, the surgeon gave her a full and frank explanation of what had happened during the operation. He apologised profusely and was very upset. She accepted his apology and was very grateful for the approach he had taken in explaining everything so clearly. Nevertheless, as time went on, she decided to bring a claim for compensation because it became clear that she had suffered financial losses and that further treatment would be costly. She was very pleased that I was able to bring the matter to an amicable conclusion for her. She felt bad for the surgeon as he had been very sorry for the harm he had caused her but the fact remained she had been injured as a result of failings in the treatment she received.

[10]Anthony Gold: Compensation for burns during surgery, 2016: https://www.anthonygold.co.uk/latest/blog/compensation-for-burns-during-surgery/

LEARNING FROM INTERNATIONAL BEST PRACTICE

Surgical fires are entirely preventable, but the absence of national guidelines has resulted in an inconsistent approach to prevention in UK hospitals.

Former Chief Medical Officer, Sir Liam Donaldson, published an article in the Annals of The Royal College of Surgeons of England, which recommended that: "*It may be that fire risk should be included in pre-surgical World Health Organisation checklists or in the surgical training curriculum. Surgical staff should be aware of the risk that spirit-based skin preparation fluids pose and should take action to minimise the chance of fire occurring*".[11]

Elsewhere in the world, surgical fires have been highlighted as a patient safety priority. The United States Federal & Drug Administration (FDA) issued new national guidance on surgical fire prevention in 2018 for all healthcare professionals involved in surgical procedures, including surgeons, surgical technicians, anaesthesiologists, anaesthesiologist assistants, certified registered nurse anaesthetists, physician assistants and nurses, as well as healthcare facility staff responsible for patient safety and risk management.

FDA advice includes recommendations relating to:

1. Conducting a fire risk assessment at the beginning of each surgical procedure;
2. Encouraging communication among surgical team members on fire prevention;
3. Procedures on the safe use and administration of oxidisers (oxygen *and* nitrous oxide);
4. Procedures on the safe use of any devices that may serve as an ignition source;
5. Procedures on the safe use of surgical suite items that may serve as a fuel source; and
6. Planning and practising how to manage a surgical fire.[12]

In England, the issue of surgical fires was last discussed at a meeting of the NHS England Surgical Safety Patient Safety Expert Group in March 2015,[13] but the issue has yet to be classified as a Never Event by NHS England. According to NHS Improvement: "Never Events are serious incidents that are entirely preventable because guidance or safety recommendations providing strong systemic protective barriers are available at a national level and should have been implemented by all healthcare providers".[14]

Given the increasing body of international evidence and prevention guidelines, along with research demonstrating that preventable surgical fires remain commonplace in the NHS, as well as the recent updated NICE Guidance[15] (released in April this 2019), expert consensus has concluded that surgical fires should be classed as a Never Event.

[11]Rocos B, Donaldson LJ. Alcohol skin preparation causes surgical fires. *Annals of the Royal College of Surgeons of England* 2012; 94(2):87-89.
[12]US Food and Drug Administration. Recommendations to Reduce Surgical Fires and Related Patient Injury: FDA Safety Communication 2018. https://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/ucm608637.htm.
[13]NHS England. NHS England Surgical Safety Patient Safety Expert Group 2015. https://www.england.nhs.uk/patientsafety/wp-content/uploads/sites/32/2015/12/ss-pseg-notes-march15.pdf.
[14]https://improvement.nhs.uk/resources/never-events-policy-and-framework/
[15]NICE. *Surgical site infections: prevention and treatment (NG125)* 2019. https://www.nice.org.uk/guidance/ng125/resources/surgical-site-infections-prevention-and-treatment-pdf-66141660564421.

SCALE OF THE PROBLEM

In the period from October to November 2018, APCO Worldwide (APCO) conducted research for the Short Life Working Group to provide an up-to-date and accurate understanding of surgical fire incidence and prevention protocols, currently in place in UK hospitals.

This research consisted of two key elements:

1. A Freedom of Information (FOI) request sent to healthcare organisations across the UK (NHS England Acute Trusts, Wales Health Boards, Northern Ireland Trusts, NHS Scotland Health Boards, NHSI, and NHS Resolution); and
2. An online consultation with AfPP members.

APCO reached out via an FOI to the following organisations:

- 135 NHS Acute (Hospital) Trusts in England;
- Seven Wales Health Boards;
- Five Northern Ireland Trusts;
- 13 NHS Scotland Health Boards;
- NHS Improvement; and
- NHS Resolution.

As part of the data gathering process for this project, APCO also reached out to members of the AfPP, to better understand their direct experience of surgical fire incidents in the operating theatre. A total of 75 responses were recorded for the online survey consultation. The questionnaires entailed both quantitative and qualitative questions, to assess data held about surgical fire incidents, prevention protocols in place and training practices.

Summary of findings from the FOI research

Discrepancy between data held at national and local levels

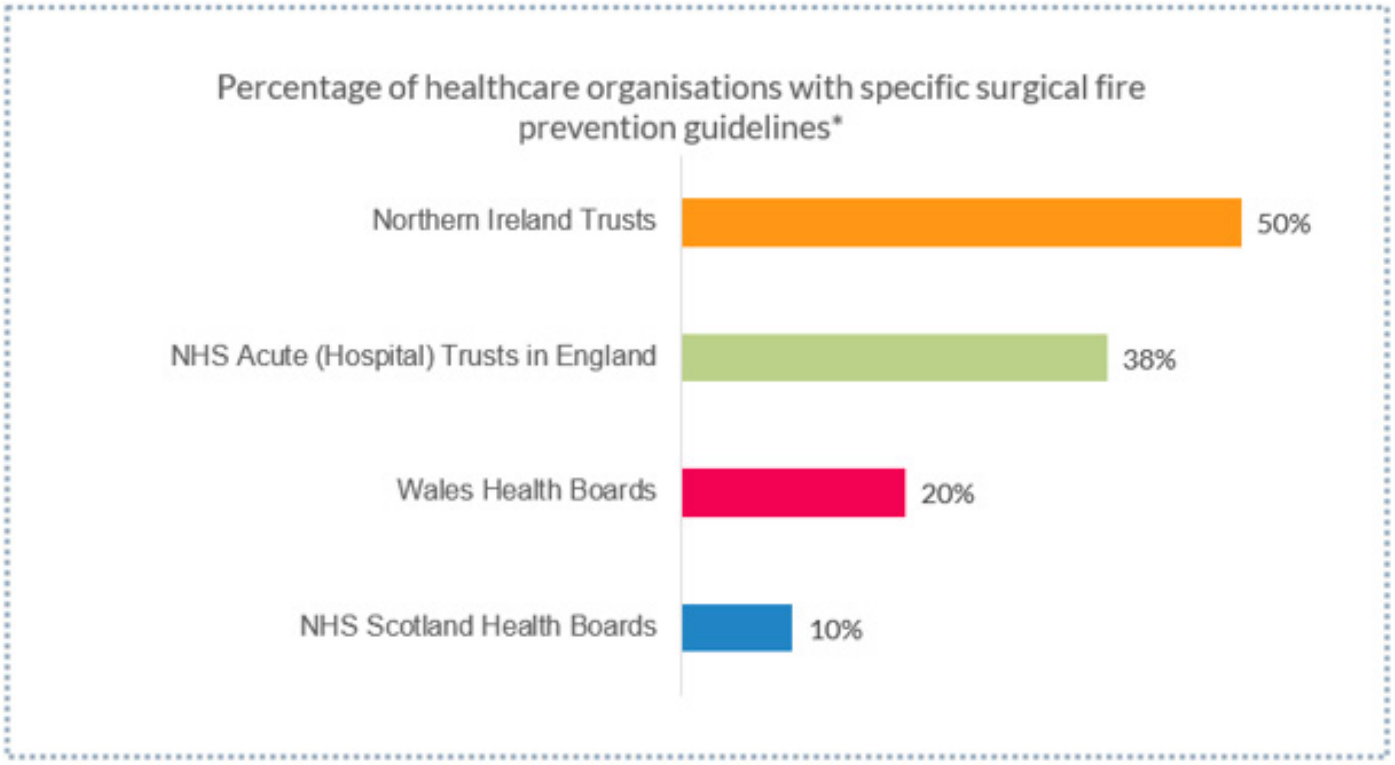
There is a significant discrepancy in incidents recorded at the Trust level and those recorded at the national level. When looking at the 2010-2018 period, there were a total of 96 recorded surgical fire incidents declared by NHS England Acute Trusts and Wales Health Boards. A search of the National Reporting and Learning System (NRLS) data from between 2004 and 2011 identified just 13 reported surgical fires.[16] A more recent search of the NRLS in England and Wales, between January 2012 and December 2018, identified 37 reported surgical fires, and 52% of the reported surgical fires resulted in some degree of harm (22% low harm, 22% moderate harm and 8% severe harm).[17] This raises questions about the true number of these incidents.

A more detailed examination and access to the full description of incidents held at the local level will be needed to draw definite conclusions about the state of reporting, but such sharp differences which emerged through the FOI process suggest there are issues to be addressed concerning clear and effective reporting of incidents, and a need to work on a standardised approach.

[16]Rocos B and Donaldson LJ. Alcohol skin preparation causes surgical fires. *Annals of the Royal College of Surgeons of England* 2012 94(2): 87-89.
[17]Rodger D. Surgical fires: Still a burning issue in England and Wales. *Journal of Perioperative Practice* 2020 30(5): 135-140

Lack of standardisation in prevention protocols

Another dimension APCO explored as part of its FOI outreach is the nature of prevention guidelines currently in place, aimed at eliminating the occurrence of any kind of surgical fire incidents in the UK's operating theatres. From the examination of the FOI responses received, it is evident only a limited number of trusts across the UK (23) have specific protocols and training programmes addressing surgical fires specifically. The wide majority of local trusts rely on general fire safety guidelines, where there is often no mention of surgical fire risks and prevention processes. Below is a detailed account of the share of local healthcare organisations for England, Scotland, Wales and Northern Ireland that have declared they have surgical fire specific prevention protocols in place.



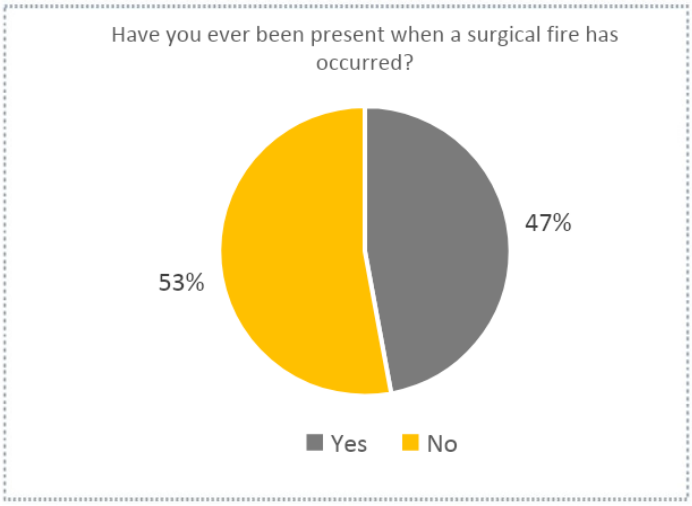
** The graph features the percentage of local healthcare organisations with specific surgical fires protocols out of the total of the responses we have received.*

Summary of findings from the AfPP survey

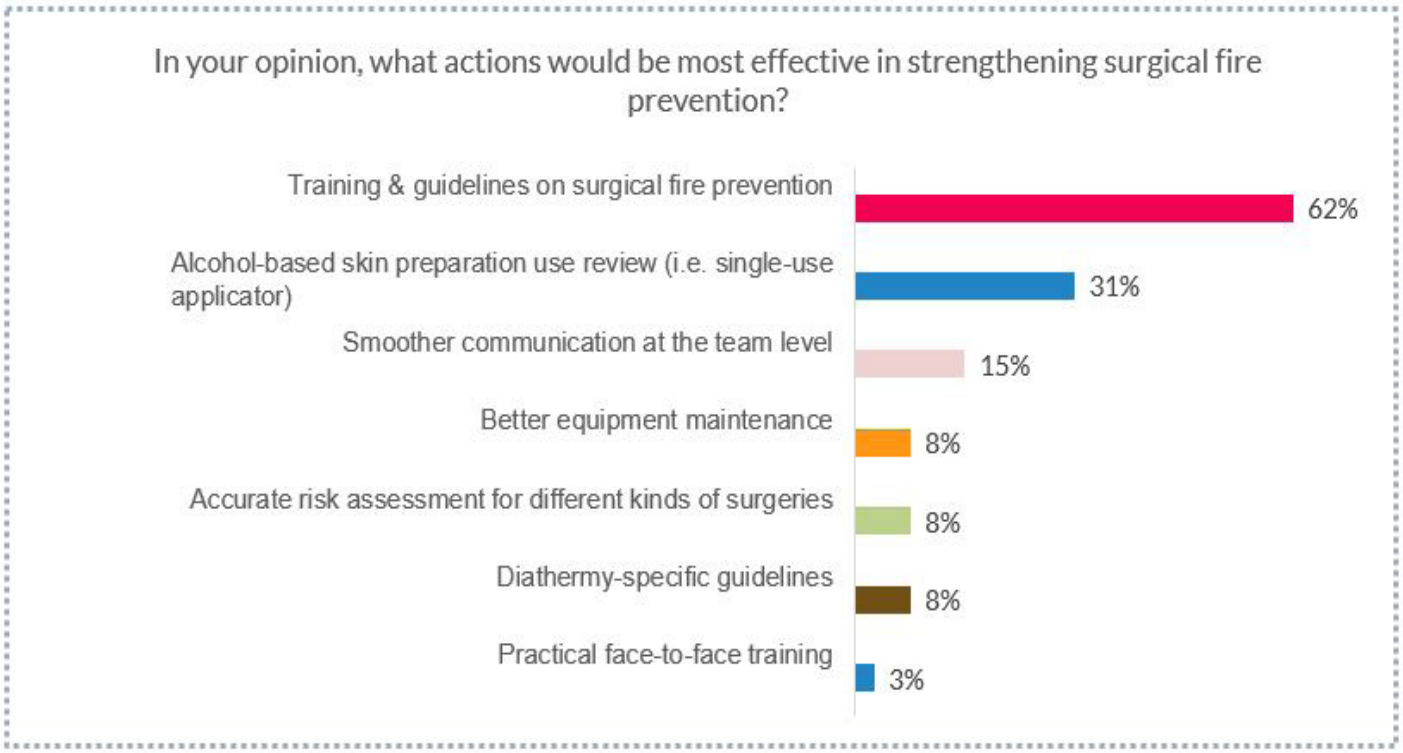
Insight into the experience of members of the AfPP

To gather a different perspective on the occurrence of surgical fires and the way they most commonly manifest, APCO also fielded an online survey among AfPP members. Their experience in the operating theatre adds a valuable practical context when interpreting the overall data collected.

The data gathered revealed that almost half (47%) of AfPP members who took the survey, reported they had witnessed a surgical fire incident. Most of the incidents reported were diathermy related (64%), almost half involved an alcohol-based skin preparation (48%), and 16% were related to equipment failure or misuse. Although the online consultation did not consult a critical mass of all hospital workers in the UK, they suggest surgical fires are a much more common occurrence than suggested by the data held by local trusts and the NRLS.



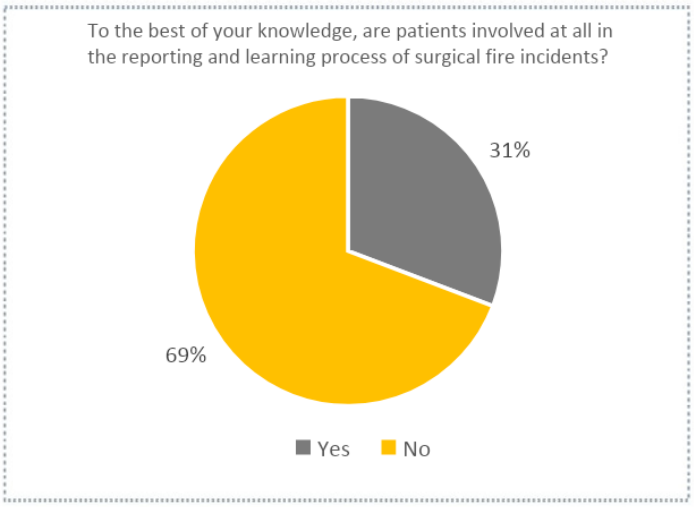
When it comes to actions that would be effective in strengthening surgical fire prevention, most respondents indicated that specific mandatory training should be adopted for all operating theatre staff, if these incidents are to become a Never Event in operating theatres across the UK. Better equipment maintenance and approach to alcohol-skin preparation application is another area that should be prioritised to ensure effective prevention, according to AfPP members.



** The graph features the percentage out of the total number of local healthcare organisations for each nation.*

Another issue that emerged from the AfPP survey results concerns the patient involvement when it comes to the reporting and learning process from surgical fire incidents.

Only one out of three respondents said that, to the best of their knowledge, patients are sufficiently involved in these processes.



Summary

The data collected from the different sources quoted above suggests the approach currently in place in terms of prevention protocols and reporting of surgical fire incidents does not manage to accurately capture the scale of the problem. A very different picture emerges from the records held across different trusts in the UK, the NLRS and the experience of operating theatre staff. There is a clear lack of an effective approach that ensures such easily-preventable incidents become a Never Event in the UK's healthcare system.

THE PREVENTION AND MANAGEMENT OF SURGICAL FIRES

In this section, information on existing guidelines and recommendations relating to the prevention of surgical fires in operating theatres has been gathered from healthcare bodies both in the UK and the US.

Recommendations by the US Food & Drug Administration (FDA), May 2018

As part of its 2018 Safety and Communications, the FDA in the US put forward recommendations to reduce surgical fires and related patient injury.[18] The FDA began by prescribing that healthcare professionals and staff who are involved in performing surgical procedures should be trained in practices to reduce the occurrence of a surgical fire. This training should be delivered periodically and should include information on the factors increasing risk, how to manage a fire if it were to occur, and how to use carbon dioxide fire extinguishers on or around patients. Training should also include regular fire drills and evacuation procedures.

The FDA also provides some more specific recommendations on reducing surgical fires, which include:

- A fire risk assessment at the beginning of each surgical procedure;
- Encouraging communication among surgical team members;
- The safe use and administration of oxidisers;
- The safe use of any devices that may serve as an ignition source;
- The safe use of surgical suite items that may serve as a fuel source; and
- Planning and practising how to manage a surgical fire.

Updated NICE Guidance, April 2019 [NG125]

The National Institute for Health and Care Excellence (NICE), recently published new guidance in April 2019,[19] which includes recommendations on appropriate skin preparation before surgery. The guidance draws attention to the risk of fire during surgery, and provides measures to mitigate these risks, including, but not only, alcoholic skin preparations.

1.3.10 If diathermy is to be carried out:

- use evaporation to dry antiseptic skin preparations **and**
- avoid pooling of alcohol-based preparations. **[2019]**

In terms of the rationale behind the additional recommendation of avoiding antiseptic solution pooling in skin preparation procedures, the committee discussed the fact that many surgical procedures require diathermy. In relation to the risk of surgical fires, it is recognised that, when a surgeon uses alcohol-based antiseptic solutions in preparing a patient, these pose a fire risk and can therefore result in burns to both the patient undergoing surgery and the surgical team. This risk is increased if the solution is not allowed enough time to evaporate, which in turn causes pooling on the skin.

In addition to **allowing time for the evaporation of the antiseptic solution to occur**, the committee also agreed that:

- Alcohol antiseptic-soaked materials, drapes or gowns should be removed before diathermy;
- Application of excessive quantities of alcohol-based preparations should be avoided; and
- No excess product should be present before an occlusive dressing is applied.

Moreover, for surgical procedures occurring next to mucous membranes, where alcohol-based solutions should not be applied due to the risk of burns, the committee agreed to instead recommend an aqueous solution of chlorhexidine as an option for skin preparation. However, due to the limited evidence they were able to obtain, the committee were unable to make a strong recommendation.

Finally, the NICE clinical guideline development committee agreed further research should be carried out in order to establish the effectiveness of different concentrations of chlorhexidine in reducing the risk of surgical site infections. To address this, they have made a research recommendation to investigate this further.

[18]US Food and Drug Administration. Recommendations to Reduce Surgical Fires and Related Patient Injury: FDA Safety Communication 2018. https://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/ucm608637.htm.
[19]NICE. Surgical site infections: prevention and treatment (NG125) 2019. https://www.nice.org.uk/guidance/ng125/resources/surgical-site-infections-prevention-and-treatment-pdf-66141660564421.

SURGICAL FIRE PREVENTION & MANAGEMENT: AFPP / SLWG GUIDELINE RECOMMENDATIONS

The aim of establishing the SLWG was to put forward recommendations for the prevention of surgical fires and guidance on tackling a surgical fire. To do this, the SLWG undertook a review of existing materials, NICE guidance, international guidelines and best practice. The SLWG and Chair of the AfPP agreed upon the following guidelines and recommendations for reducing the likelihood of incidents occurring, and the steps to follow in the event of a fire. These recommendations have been developed based on international best practice and the expert guidance from the ECRI Institute, a US patient safety non-profit organisation, in collaboration with the Anesthesia Patient Safety Foundation (APSF).[20]

In addition to the recommendations highlighted below, mandatory training and education modules for all hospital staff working in and around the perioperative setting need to be introduced. This will reinforce the recommendations, raise awareness and knowledge of this issue, and therefore reduce the likelihood of incidents.

"Surgical drapes and cotton towel fires easily ignite when oxygen builds up beneath them during certain surgeries." (Photo credit Mark E. Bruley Consulting Investigator and Author, Medical Technology Accidents, Vice President Emeritus, Accident & Forensic Investigation, ECRI Institute. Photos reprinted with permission of ECRI. ©ECRI 2020.)

1. Ensure the safe use of devices that may serve as an ignition source:

- **Inspect all instruments for evidence of insulation failure (devices, wires and connections) prior to use. Do not use if any defects are found;**
- **Use a return electrode monitoring system;**
- **Tips of cautery instruments should be kept clean and free of char and tissue;**
- **When not in use, place ignition sources such as ESUs, electrocautery devices, fibre optic light sources and lasers in a designated area away from the patient (for example, in a holster or a safety cover) and not directly on the patient or surgical drapes. They should also be placed in standby mode; and**
- **Always ensure a carbon dioxide fire extinguisher is available in theatre when lasers are being used, and staff must have received training in its use.**

Important notes on ignition sources:

- If an ignition source must be used, be aware that it is safer to do so after allowing time for the oxygen concentration in the room to decrease. It may take several minutes for a reduction of oxygen concentration in the area even after stopping the gas or reducing its concentration;
- Recognise that other heat generating items, including drills, burrs and argon beam coagulators can also serve as potential ignition sources;
- If a monopolar electrosurgical unit is used, do not activate when near or in contact with other instruments (in addition to serving as an ignition source, monopolar energy use can directly result in unintended patient burns from capacitive coupling and intra-operative insulation failure).

[20]ECRI Institute. New clinical guide to surgical fire prevention. Patients can catch fire--here's how to keep them safer. Health Devices. 2009;38(10):314-332.

2. Be aware of fuels and accelerants in the operating room setting:

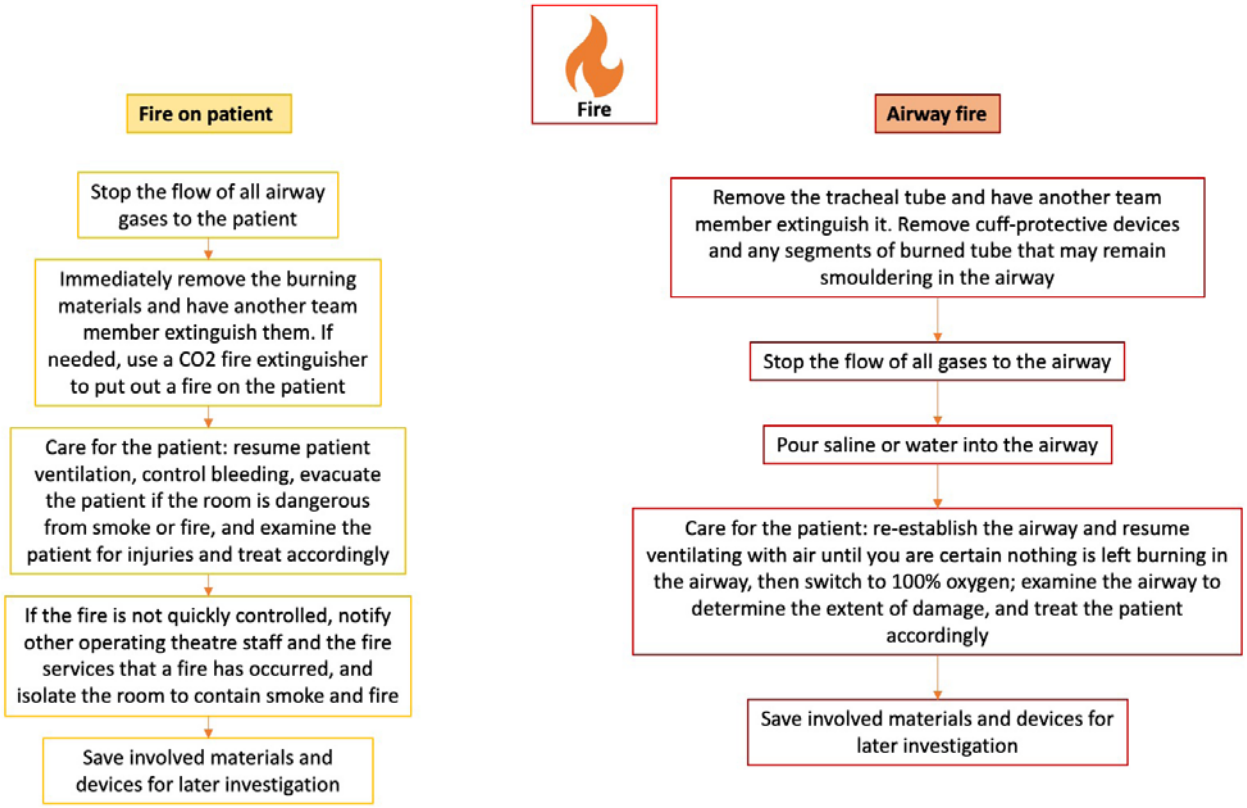
- **The quantity of flammable fluid used to prepare the skin should be kept to a minimum in order to avoid run-off and pooling, either on or around the patient;**
- **Precautions should be taken to prevent pooling underneath drapes or in skin creases, for example the groin and umbilicus. Any run-off that occurs should be contained by absorbent material placed around the patient, which should be removed before the drapes are applied; and**
- **The AfPP recommend that a closed oxygen delivery system should be used. If an open delivery system is used, those in the operating theatre should take additional precautions to exclude oxygen from the operative field. For example, this includes using draping techniques that avoid the accumulation of oxygen in the surgical field.**

3. Take steps to reduce the risk of airway fires:

- **The potential for airway fires should be minimised during surgical procedures involving the airway, by placing wet radiopaque sponges or throat packs in the back of the patient's throat. Placing wet radiopaque sponges in the back of the patient's throat assists with decreasing or preventing oxygen leaks from the endotracheal tube; and**
- **Inflating endotracheal tube cuffs with solutions helps increase the temperature required for the endotracheal tube cuff to rupture after being in contact with the ignition source. The tinting of the solution provides a visual indicator of cuff rupture.**

4. Train staff on how to respond to a surgical fire:

Although rare, surgical fire incidents continue to occur, and therefore it is crucial for theatre staff to have training and information at hand to extinguish a fire. The SLWG and AfPP recommend the following steps for extinguishing a surgical fire:



5. NHS to adopt a risk assessment/checklist:

Research has identified a number of existing fire safety risk assessments and protocols that could be replicated or adapted for us in the NHS, given the lack of centralised NHS guidance. After researching and analysing current published surgical fire risk assessments, the SWLG recommends adopting a points-based risk assessment procedure, consisting of three initial statements to be answered with either 'yes' or 'no', dependent on if it applies to that particular instance.

Surgical Fire Risk Assessment

Fire risk assessment date/time (GMT)	DD/MM/YYYY	00:00
Procedure site or incision above the xiphoid	Yes ☐	No ☐
Open oxygen source (face mask/nasal cannula)	Yes ☐	No ☐
Ignition source (electrosurgical or electrocautery device, laser, fibre optic light source)	Yes ☐	No ☐
Fire risk score (no. of boxes ticked 'yes')		
0-2 boxes ticked 'yes'	Initiate the **Routine Protocol**	
3 boxes ticked 'yes'	Initiate the **High-Risk Protocol** (which also includes the routine protocol)	

Routine Protocol

1. **Fuel:**
   a) When an alcohol-based skin preparation solution is used, apply the minimal amount of solution that is necessary and allow sufficient time for fumes to dissipate before draping;
   b) Observe the manufacturer's recommended drying time (minimum of three minutes). Do not drape patients until the alcohol-based skin preparation is fully dry;
   c) Do not allow pooling of the skin preparation solution (including under the patient or in the umbilicus), and consider the use of an appropriately sized skin preparation applicator;
   d) Remove any remaining skin preparation solution from the sterile field as soon as possible after use; and
   e) Utilise standard draping procedure.

2. **Ignition source:**
   a) Protect all potential ignition sources when not in use (electrosurgical/diathermy pencil holster, laser in standby mode, etc.);
   b) Activate ignition source only when active tip is in line of sight (this is especially important if operating through a microscope);
   c) Deactivate any ignition source following use at the surgical site; and
   d) Check all electrical equipment before use.

High Risk Protocol

a) Use appropriate draping techniques to minimise oxygen build-up underneath (for example, tenting the drapes, use of an incise drape, etc.);
b) ESU setting should be minimised consistent with therapeutic need at the target tissue;
c) Encourage the use of moistened swabs, especially during tonsillectomy;
d) Have a container of a sterile aqueous solution and a 20 or 50ml syringe available for extinguishing purposes only nearby; and
e) Anaesthesia team considerations:
   - A syringe full of an aqueous solution will be available, in reach of the anaesthesia team, for procedures within the oral cavity;
   - Documentation of oxygen concentration/flows; and
   - Avoid the use of open supplemental oxygen unless clinically indicated; consider using less than 30% oxygen or using an LMA or ET tube.
     Note: This recommendation is significantly expanded upon in the 'training and educational materials/syllabus' below.

TRAINING AND EDUCATIONAL MATERIALS / SYLLABUS

The Short Life Working Group agree that effective education and training are vital for preventing future incidences of surgical fires. Raising awareness of the risks, providing detailed guidance on how to mitigate these and encouraging perioperative teams to consider their individuals roles in surgical fire prevention and management, are what led to a statistically significant decline of surgical fires in the US.[21] Despite some forms of more general fire safety training being mandatory for NHS staff during their induction and ongoing employment, this general training does not address the unique aspects of preventing and extinguishing a surgical fire. The response to different kinds of surgical fire – airway, non-airway and equipment – can differ, as can an individual's role depending on who is present at the time.

For preventative and management strategies to be effective will require additional education and training. Such a programme would also go some way in raising awareness of the potential risks of fires in the operating theatre. Surgical fires used to be commonplace but have declined in line with the use of highly flammable and explosive anaesthetic gases over the last 40 years. This in turn has reduced awareness of the risks of fires. Therefore, proactive awareness raising is needed to highlight that some risks still remain, and that poor practices can increase the risk of a surgical fire and lead to serious harm to the patient. This is further complicated by the numerous and often unconnected number of risk factors that still exist, as demonstrated by the following examples:

Swab soaked in chlorhexidine gluconate 0.5% in 70% v/v used to wipe out (surgical) cavity. Monopolar forceps diathermy used on bleeding point. Suddenly it felt very hot by my left index finger and I realised the diathermy had set fire to the swab and drapes on the right side of the patient... The swabs and drapes pulled off...flames put out with water and blanket over drapes. Immediately noticed burns to skin on patient on the right lower chest and upper abdomen.

Safe Anaesthesia Liaison Group[22]

The tracheostomy incision was performed between the 4th and 5th tracheal cartilages using monopolar diathermy in cutting mode with an intensity adjusted to 30. The patient was ventilated with 100% oxygen to prevent desaturation. Immediately after the incision, a 15 cm flame burst from the tracheostomy orifice for 2 seconds. Ventilation was stopped immediately, and normal saline was used to extinguish the flame. Black smoke was then observed, corresponding to combustion of the endotracheal tube. The burnt endotracheal tube was removed and was replaced by a Shiley cuffed tracheostomy cannula. Examination revealed burns of the infrahyoid muscles and a very limited skin burn.

Gorphe et al[23]

Shortly after induction, the patient desaturated despite 100% oxygen and lung recruitment manoeuvres. The surgical team decided to insert a chest tube emergently to drain the empyema to improve respiratory function. A non-functioning drainage catheter that was in situ was removed and placed on the operating table beside the patient. Skin was prepared using chlorhexidine gluconate 0.5% w/v in methylated spirit solution and iodine. Soon after, cotton drapes were used to cover the patient. After the initial incision for chest tube insertion, electrocautery was introduced. Smoke and a smell of something burning was immediately noted by the surgical team. The drapes were removed and the drainage catheter with a burnt tip was discovered beside the patient. The patient suffered second degree burns to his chest wall.

Tan and Thong[24]

[21]Bruley ME, Arnold TV, Finley E, Deutsch ES, Treadwell RT. Surgical fires: decreasing incidence relies on continued prevention efforts. PA Patient Safety Advisory 2018; 15(2). http://patientsafety.pa.gov/ADVISORIES/Pages/201806_SurgicalFires.aspx.
[22]Safe Anaesthesia Group Liaison Group. Patient Safety Update. 2011. https://www.rcoa.ac.uk/system/files/CSQ-PS-PSU-JULY2011.pdf
[23]Gorphe P, Sarfati B, Janot F et al. Airway fire during tracheostomy. European Annals of Otorhinolaryngology, Head and Neck Diseases 2014; 131(3):197-199.
[24]Tan Z, Thong SY. Surgical fire caused by electrocautery in ambient air. Proceedings of Singapore Healthcare 2015; 24(3):195-197.

At present, there are a number of written guidelines and video resources available from organisations primarily based in the US These include the American Society of Anesthesiologists,[25] the Association of Operating Room Nurses,[26] and the Anesthesia Patient Safety Foundation.[27] More recently in the UK, the Association of Anaesthetists also include a patient fire in its Quick Reference Handbook,[28] which provides guidance for airway and non-airway fires. There have also been some recent novel approaches developed to mitigate the risks of surgical fires, such as the use of immersive virtual reality or other simulation-based scenarios to encourage awareness.[29, 30] Performing an operating theatre fire drill is another way to raise surgical fire awareness.[31, 32]

Additionally, the presence of a visible surgical fire algorithm, acting as a cognitive aid, could be displayed in each operating theatre to reinforce awareness.[33] Nevertheless, it is still not clear that existing guidance on surgical fires is being sufficiently disseminated to perioperative staff and students, and much more work is required by higher education institutions and professional bodies. We therefore advise surgical fire training should be made mandatory across the NHS and private sector, and should be updated at least every two years.

[25]Apfelbaum JL, Caplan RA, Barker SJ. Practice advisory for the prevention and management of operating room fires: An updated report by the American Society of Anesthesiologists Task Force on Operating Room Fires. Anesthesiology 2013; 118:271-90.
[26]AORN. Fire Safety Tool Kit 2019. https://test.aorn.org/guidelines/clinical-resources/tool-kits/fire-safety-tool-kit.
[27]Anesthesia Patient Safety Foundation. Prevention and Management of Operating Room Fires Video 2010. https://www.apsf.org/videos/or-fire-safety-video/
[28]Association of Anaesthetists. Quick Reference Handbook Guidelines for Crisis in Anaesthesia 2019. https://anaesthetists.org/Portals/0/PDFs/QRH/QRH_complete_January_2019.pdf?ver=2019-05-05-171156-577
[29]Dorozhkin D, Olasky J, Jones DB. OR fire virtual training simulator: design and face validity. Surgical Endoscopy 2017; 31(9): 3527–3533.
[30]Corvetto MA, Hobbs GW, Taekman, JM. Fire in the Operating Room. Simulation in Healthcare 2011; 6(6): 356-359.
[31]Flowers J. Code red in the OR—implementing an OR fire drill. AORN J 2004 79(4):797-805.
[32]Graling PR. Fighting fire with fire safety. AORN J 2006 84(4): 561-3.
[33]Jones TS, Black IH, Robinson TN, Jones EL. Operating Room Fires. Anesthesiology 2019; 130(3): 492-501.

CONCLUSION OF RECOMMENDATIONS

Following the SLWG's series of roundtable meetings, it was agreed that the opportunity for inclusion in the National Safety Standards for Invasive Procedures (NatSIPPs) should be explored as a priority. With the formation of the CPOC and the porting of responsibility for hosting NatSIPPs transferring to CPOC, the SLWG agreed this report and recommendations should form the basis for initiating discussions with the CPOC steering committee.

The impact of surgical fires is devastating for those who experience them, and this impact is not only to the patients who suffer physical or mental injury, but also to the healthcare professionals who witness such incidents. To add to this, the cost of operating room fires to the NHS should be a major concern; NHS Resolution, for example, paid out £13.9m in damages and legal costs on behalf of NHS organisations.

In light of this, it is essential for the NHS to put formal guidance in place to mitigate the risk of fires breaking out in operating rooms, helping to prevent harm to both patients and NHS healthcare professionals.

The SLWG emphasises, strongly, the need for the surgical fire recommendations included in this report to be placed at the top of the Centre for Perioperative Care's agenda going forward. This should allow for the development of clear guidance and the delivery of training to healthcare professionals, to give them the knowledge on how to prevent surgical fires, in addition to clear instructions on how best to deal with a fire breaking out in the surgical setting and build on NICE guidance published in 2019, which includes recommendations on appropriate skin preparation before surgery. As evident from these examples, there is a growing awareness of the impact of surgical fires both within and outside the UK along with the need to continue raising awareness of the issue, as well as for the NHS to provide consistent, effective training to healthcare professionals.

To conclude, and as outlined above, there are several important recommendations the SLWG would like to propose towards the prevention of surgical fires in the UK. These include the safe and correct use of devices, including lasers which can emit sparks, correct skin preparation and technique, including the avoidance of pooling underneath and on the skin, in addition to the overarching recommendation to provide thorough, regular and consistent training for healthcare professionals, in order to inform them of how to prevent a fire incidence, and how to react if one does break out.

The SLWG have collaborated on this project to ensure we can provide a package of informative and concise recommendations, training materials/ syllabus and a risk assessment around the significant issue of fires occurring in operating theatres. We hope the importance of putting effective protocols in place around this is evident, and that there is agreement on the urgent need for surgical fires to be attributed a Never Event status.