AS WE WERE...

Fires and explosions

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The concept of a 'fire triad' comprising an ignition source, fuel and an oxidising agent is well known. An explosion is defined as a sudden, loud and violent release of energy.

Both are recognised hazards in the operating theatre, but the incidence and cause have changed since the earliest reports in the mid-nineteenth century. Ether was first introduced in the US by Morton in 1846, and by 1847 reports of such events occurred in both the popular and the medical press as far away as Spain and Germany.[1,2]

A century later, *Recent Advances in Anaesthesia*[3] included a chapter on 'the Explosion Risk of Anaesthesia', driven by the increased trend for surgeons to use 'electrical and other apparatus using heat'. In 1948 in Great Britain, there were approximately 100 cases of burns of the eyebrows, lips and pharynx from ether explosions alone.

Explosive mixtures

The anaesthetic agents capable of igniting or exploding in 1948 included ethylene, acetylene, cyclopropane, ethyl chloride, and the anaesthetic ethers. Air, oxygen or nitrous oxide acted as oxidising agents. In 1939 in the US, the explosion rates for ether, ethylene and cyclopropane were reported as being between 1 and 4 per 100,000 anaesthetics, with a mortality rate of 1 in 1,150,000.[3]

These agents were still cited as explosion risks in 1964.[4] By 1993 the advice was to avoid flammable agents completely if possible.[5]

The source of Ignition

In 1948, the possible sources of ignition were listed as static electricity, non-static electricity, sources of heat and spontaneous ignition. Sources of heat included cigarettes, lighted matches, candle flames, hot wires, diathermy, light sources and, when giving anaesthetics in patients' homes, open fires, gas stoves and electric fires with exposed elements.

While one would hope that cigarettes and naked flames have been removed from this list and anaesthetics are no longer given in patients' homes, other sources have not changed.

Management of risk

Antistatic precautions

In 1937, the American Society of Anesthesiologists found static electricity to be the dominant source of ignition, and recommended that the humidity in theatres should not be less than 60%, that all operating floors should be antistatic, that all anaesthetic equipment should be made of conductive material, and that all personnel and equipment should be earthed.[6] These principles are still the recommendations, but are expensive to implement. Since the early 1990s in the UK, it has been decided only to provide antistatic facilities in new buildings if the anaesthetic department and the health authority agreed that flammable agents might be used.[7]

Electrical equipment

In 1948 equipment needed to be spark proof and regularly serviced, and electrical sockets more than three feet from the floor to avoid contact with heavy layers of inflammable vapours. Current recommendations, if flammable agents have to be used, are to create a 'zone of risk' extending 25 cm from any part of the apparatus or the patient's airway that contain the anaesthetic mixture, and to exclude any potential source of ignition from this zone.

Diathermy

By the 1960s, diathermy was second to static electricity as a cause of explosions, and the recommendations were either to avoid explosive anaesthetics completely or to stop their administration five minutes before using diathermy, blowing air through the apparatus to remove any residual vapours. Nitrogen or carbon dioxide could be used to wash out ignitable gases in the mouth or deep cavities.[4]

Today's challenges

The variety of new agents and anaesthetic techniques have eliminated many of these risks; however, surgical advances have provided new challenges. The introduction of laser surgery creates such an intense source of ignition that rubber, PVC or silicon tracheal tubes and drapes can all act as fuel. Current recommendations include the use of flexible metal or metallic-coated tubes and the filling of the cuffs with saline. Alternatives are the avoidance of tracheal intubation and the use of insufflation, injector techniques or high-frequency ventilation. Oxygen concentration should be kept below 30% where possible, and intermittent flushing with 100% nitrogen still has its place.

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In 1948, there were approximately 100 cases of burns from ether explosions

These precautions have not eliminated the problem completely, but they have reduced the incidence of these events. A literature search revealed one case report in 2017. In this case a spark between a diathermy probe and a titanium implant ignited the insulation on the diathermy probe itself.[8] Despite the reduced risk, awareness and vigilance are as important today as in the past.

References

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