GUIDELINES FOR FIRE SAFETY IN THE INTENSIVE CARE UNIT

This document was prepared by:

Dr S A Ridley MD FRCA Consultant in Anaesthesia & Intensive Care
Norfolk & Norwich Healthcare NHS Trust

and

Mr G Parry
Manager, Fire Safety Services
Norfolk Mental Healthcare NHS Trust

On behalf of Council of the Intensive Care Society advise & inserts were received from Mr M Gale, publications manager, Loss Prevention Council.

Index

Summary

Fire in the Intensive Care Unit (ICU) requires a rapid response to ensure safety of patients and staff. This can be achieved if the following points are considered:

- Staff must be aware of the principles of the hospital's fire policy and how the ICU fire policy dovetails into this.
- Staff working in the ICU must be prepared to make an early decision to evacuate. Under such circumstances, their response depends upon their having regular fire training and knowledge of evacuation procedures and escape routes. Life support equipment must be readily available as oxygen and power supply to the ICU may be lost soon after the outbreak of fire. Emergency evacuation will involve triage of patients. If fire spreads quickly and uncontrollably, it may not be appropriate to attempt to evacuate all patients.
- Staff should appreciate that the hospital's designated officer for fire has initial responsibility for the safety of staff and patients. Once the Fire Service attend the scene, the Senior Fire Officer will assume control and his instructions should be obeyed without question.
- Regular planning and training, appropriate fire containing measures and readily available life support equipment for evacuation will reduce the risk to life.

Introduction

Hospital fires can be particularly serious because of the difficulties and dangers associated with the emergency evacuation of patients. As serious fires in hospitals are infrequent, there is little opportunity for staff to learn from experience. Forward planning and training are essential. It is impossible to plan for all eventualities because circumstances vary. However, each hospital will have a fire policy, because this is an obligatory requirement laid down by the Department of Health [1]. Senior members of the intensive care unit (ICU) staff, both medical and nursing, must be familiar with their hospital's overall fire policy and how this policy affects the ICU.

The aim of this booklet is to provide general guidelines and to highlight areas which warrant particular attention in the ICU and in the staff's response to fire. When considered in combination with the hospital's fire policy, this document should ensure the development of a rational approach to the problem of a potential fire in the ICU.

General

Statutory requirements

Chief Executives have a number of statutory requirements that relate to NHS premises. As a result, there are obligatory instructions that must be observed by all staff in NHS Trusts at all times. One of these requirements is the development of the Trust's "Fire Precautions Policies and Procedures" document.

Fire Precautions Policies and Procedures

The Fire Precautions Policies and Procedures document should be available in every department of NHS Trusts. This document typically contains the duties and responsibilities of the managerial staff at a fire incident (including the Chief Executive as well as the local fire safety manager or deputy). The general duties and responsibilities of the staff relating to their training in fire prevention are also specified. The document may include appendices which detail protocols for action on discovering a fire, methods of raising the alarm, activation of fire alarms by smoke or heat detectors and action on hearing the alarm in theatres, general wards, outpatients, maternity departments, non-patient areas, *etc.* The duties of the nominated officer for fire (or deputy), security staff, switchboard operators, works and domestic staff upon hearing the fire alarms may also be described. The local fire policy for the ICU cannot be developed without reference to this document. Irrespective of the specialised clinical service provided by ICU, the ICU fire policy must dovetail with the hospital's overall policy.

Principles of fire control

The main principles of fire control are:

- prevention
- rapid detection
- effective containment
- rapid extinction

The control of fire depends upon physical factors, such as the design and construction of the ICU, equipment and furnishings, and finally the current fire policy.

The following paragraphs specify aspects of fire safety which require specific attention.

ICU design

The design of a new ICU offers the opportunity for key fire prevention and control features to be incorporated [2]. Internal design, number, position and width of escape exits should be considered. Ideally evacuation of the ICU should be possible via three separate fire escapes to different safe areas; location of the ICU at ground level will ease evacuation. Safe evacuation sites with sufficient space must be identified and their services, including medical piped gases, vacuum and electrical power, should be sufficient to support critically ill patients.

Staff working in existing ICUs must make their current facility as safe as possible by ensuring that appropriate equipment is available [3] and that fire standards for room furnishings are met [4].

Fire alarm

Ideally, hospitals should be equipped with an analogue addressable (AA) fire alarm system with the main panel located in the hospital's telephone switchboard and a repeater panel positioned in the ICU [5]. The AA system enables ICU staff to quickly identify the location of a fire and provide them with additional time for a balanced decision about what actions may be necessary.

Apart from the kitchen, each room or area in the ICU should be provided with a smoke detector; the kitchen and some other areas (e.g. staff rest room) should have heat detectors. There should also be audible or visual fire alarms throughout the department.

It is usual for the fire alarm signal for the majority of patient care areas within the hospital to be audible. However, sirens and bells may cause distress to both patients and relatives. ICUs are best fitted with a visual type of warning system, e.g. oscillating lights or flashing beacons. These avoid confusion with the audible alarms on clinical equipment.

Containment and separation

Although open plan areas in an ICU have numerous clinical and other advantages, from a fire control perspective, they have major drawbacks. Containment of the fire is achieved by dividing a single hospital floor into places of temporary safety (fire zones) separated by fire doors. This design prevents rapid spread of fire and reduces the chance of the fire becoming large. Adequate containment is crucial in an ICU because it provides time for staff to carry out supervised and controlled evacuation of patients. Ideally, ICUs should be designed with three fire exits leading to different fire zones, where each zone provides a minimum of thirty minutes fire protection. Fire doors separating such zones can be recognised by their weight and the need for additional hinges, automatic closures, wired glazing, and heat expanding edge seals. Containment precautions must go through false ceilings up to the soffit, unless the false ceilings meet with the minimum of 30 minute fire resisting requirements. During redecoration or alterations to the ICU, doors and glazing should be replaced appropriately, and door seals should not be removed nor painted over.

"At risk" room

The designation of an "at risk" room depends upon its contents rather than its label. Combustible materials should be kept to an absolute minimum and all furnishing and fittings must conform to Hospital Technical Memorandum 87 Textiles and Furniture issued under "Firecode" [4]. Rooms should be used as designated, i.e. office or store room and not a combination of both. All rooms and areas within the ICU should be considered to be "at risk" rooms.

Staff training and fire practice

It is a statutory requirement for all staff to receive fire training at least once each year. The hospital fire policy document will detail the types of training that are available for staff. From time to time, practice evacuations and exercises should be held. This will usefully alert staff to what may be expected of them and improves liaison with the Fire Service. It would be unwise and dangerous to carry out a practice fire drill with genuine patients. However, the staff themselves may act as patients and a number of scenarios exercised. In such a way, local difficulties might be identified and possible solutions considered in conjunction with the Fire Service and Trust's fire officer. Training should include a "fire exit signpost following exercise" which familiarise staff with the possible routes for evacuation of their visitors, patients and themselves.

New staff

New staff are required to attend the first available induction course. On their first working day they should be given instruction by their line manager on the fire routine and what part they are expected to play in any fire incident. They should receive a tour of the department during which they must be shown the fire alarm points and means of escape.

Fire extinguishers

The ICU should have an adequate supply of water and carbon dioxide (CO_2) fire extinguishers. Foam (AFFF) extinguishers are not recommended for use in ICUs because of the possible corrosive effect if used in the vicinity of clinical equipment. On the other hand, CO_2 will extinguish the fire but cause little damage to equipment. The choice of equipment, and its siting is the responsibility of the hospital's fire officer. He/she should be consulted whenever there are changes to the ICU environment, or when there is need to resite an extinguisher. A list of the different types of fire extinguishers and their appropriate uses is given in Table 1.

Fire in hospital but outside ICU

If a fire occurs in the hospital, but outside the ICU, the fire alarm will be an audible intermittent alarm. If the fire alarm has a visual signal, there will be a noticeable difference in the oscillations. This warns the ICU staff that there is a fire incident in the hospital and that evacuation procedures may require implementation. Local fire policy and procedures will dictate the actions to be taken at this stage, so that the following paragraphs can only act as a general guide.

Preparation of patients

The patients should be clinically prepared for evacuation. This will almost invariably require some modification of their ICU management and the collection of additional equipment (see later). The senior members of the ICU staff already present should establish a rank order of evacuation should it become necessary. Clinical circumstances will determine which patients should be moved first: the principles of triage apply. However, because the commonest cause of death in a fire is inhalation of toxic gases or fumes, those patients connected to closed breathing systems will remain safe until disconnected and exposed to local atmospheric pollution, or until the electrical or gas supply to the ICU fails. The possible loss of electrical or gas supply may be important in determining the order of evacuation.

Order of evacuation

If the fire is likely to be controlled then leaving the most unstable patient, in the hope that the patient will not need evacuating, may be a wise and safe option for both the patient and staff. On the other hand, if the fire is likely to spread rapidly, then the patients nearest the source of the fire should generally be moved first. It is important to emphasise that decisions on which patients to move must be taken at a local level and must be taken by the most senior member of staff already present in the ICU. Valuable time should not be wasted attempting to contact senior staff not present on the ICU: staff must spend their time preparing patients for evacuation.

Role of Fire Service

When fire is spreading from elsewhere in the hospital, the decision to evacuate the ICU is normally taken by the Senior Fire Officer who will already be present as the Fire Service attempts to contain the fire. However, if the fire develops quickly before the Fire Service arrives, the hospital's nominated officer for fire will order the evacuation.

The Senior Fire Officer will have overall control of a fire incident and is responsible for all personnel within the fire area. This officer can be identified by either a white helmet with a number of stripes (the width and number indicating rank) or a yellow helmet (indicating a sub officer) with one or two stripes. The Senior Fire Officer will liaise with clinical staff on the ICU and may require, in addition to information about the layout of the unit, some technical information. This might include the sites of gas control valves, electrical power supply, sites of gas cylinders (oxygen, air), flammable materials and hazardous substances (e.g. nitric oxide).

The Senior Fire Officer has ultimate responsibility for the decision to evacuate and has the authority to ask the police to assist with his evacuation in the event of any difficulties arising. His/her instructions must be complied with without question.

Evacuation of the ICU and progressive horizontal evacuation

The ICU fire policy should lay down the plans for evacuation of the ICU. Evacuation may be along the lines of progressive horizontal evacuation, i.e. evacuation to clinical areas on the same floor but further away from the source of the fire and beyond at least one set of fire doors. If the ICU requires evacuation, then additional personnel (coming from other areas as designated within the hospital's fire document) will arrive.

All the windows and doors should be closed; all visitors should be asked to leave the area via a safe route to a point of safety. These are always signposted, but staff should be aware of the designated routes (see training). Ideally, progressive horizontal evacuation to another area of the hospital capable of sustaining critically ill patients (e.g. the operating department or recovery wards) should be possible. Under these conditions, the equipment required to sustain patients is more limited than that required for evacuation to areas outside the main hospital building (see later). It may be possible to transfer some of the larger items of life support apparatus with the patients (e.g. ventilators); this will facilitate their treatment in the temporary evacuation site.

Evacuation of the ICU to ground level

If an ICU is located above ground floor level then evacuation to wards at ground level may need to be undertaken. This may require:

- evacuation sheets and additional staff, if the patients are to be evacuated down stair wells.
- some hospitals will have designated fire lifts which can be safely operated in such circumstances. If circumstances permit, the Senior Fire Officer will designate a lift for evacuation. This will be manned and controlled by the Fire Service. Clinical staff are required to designate a rank order for evacuation of patients, but the movement of patients will be controlled by the Fire Service.

Such evacuation is fraught with difficulties and dangers and requires the same considerations as for fire within the ICU.

This is much more serious. The fire may spread rapidly leading to confusion and panic. It is important therefore that command and control of patients, staff, relatives and assistants is maintained.

Command and control

Once the alarm is raised the ICU will be attended by the hospital's nominated officer for fire or his deputy. The deputy may be the clinical site manager (after hours) or another senior designated person. The nominated fire officer will attend all fire incidents and will be present to seek advice with regard to patient evacuation and determine with clinical staff as to how this evacuation should take place. He/she will be in charge of the incident until the arrival of the Fire Service.

Fire Service response

It is most important to emphasise that in the first instance the management of fire is a local problem because it takes time for the Fire Services to arrive. The Fire Service response (time and number of appliances ["predetermined attendance", PDA]) requires that, in a city centre, three appliances attend, two within 5 minutes, and a third within 8 minutes. In a rural area, the PDA is one appliance within 20 minutes. ICUs are more likely to be found in city centres and can expect the former response.

Fire management

ICU staff should identify the source of the fire from the fire alarm repeater board in the ICU. They should ensure that the hospital switchboard have raised the alarm. Attempts should be made to control the fire without endangering personnel. Failure to control the fire with the use of fire extinguishers is an indication for immediate evacuation from the ICU. If the ICU is to be evacuated, then the unit's oxygen supply will almost certainly need to be turned off to control further fire spread. This decision can be crucial if the ICU ventilators require a source of high pressure gas to function, and there are no other sources immediately available e.g. cylinders with appropriate terminal outlets. The timing of closure of the oxygen pipeline supply will have a significant bearing upon the survival and safety of patients receiving mechanical ventilation. If the fire is spreading rapidly and uncontrollably, then the oxygen supply may have to be turned off irrespective of the dire consequences this may have for some patients.

Smoke and fumes could be spread by air conditioning ducts. However, modern air conditioning units are fitted with dampers which are activated automatically by smoke or heat detectors. In older systems, the main air conditioning plant may be shut down by automatic cut off switches.

Evacuation of the ICU

Evacuation of the unit depends upon its internal design, the rate and spread of fire and the danger to personnel. In such catastrophic circumstances, it is important to remember that the overall likelihood of survival is paramount. Staff must not be put at risk. They must not be expected to risk their lives. Circumstances such as the size, proximity, rate of spread, smoke and fumes will dictate which patients should moved and when, i.e. the order of priority and the likelihood of survival (triage).

Triage

Certain forms of life support treatment cannot be continued during evacuation, because of power supply, bulk, or patient connection (long vascular lines etc.). Examples might include intra-aortic balloon pumps, extracorporeal oxygenators, or the more familiar continuous haemofiltration equipment. In some circumstances, disconnection may result in the patient's demise. Staff may have to remain with the patients, providing the staff are not placed in danger. Such seriously ill patients may have to remain in the ICU until evacuation is nearly complete or the fire brought under control. Evacuation may be a last resort.

Equipment required in case of evacuation due to fire

General considerations

The equipment required in case of fire depends upon the local circumstances. These include the location of the ICU, extent and severity of the fire and whether the ICU is to be evacuated in a planned manner to another part of the hospital capable of sustaining critically ill patients, e.g. the recovery room, or whether the whole hospital building is to be evacuated. However, in all circumstances, the equipment required for evacuation must be immediately available. The equipment will be similar to, but slightly modified from, that required for intra-hospital transfer and should enable the ICU environment to move with the patient. The quantity of equipment required will exceed that in any transfer simply because of the number of patients involved.

Self reliance

Self reliance by the ICU for equipment, disposables, drugs and fluids is essential. Because there may be restricted access to other parts of the building and even to the ICU after evacuation, all the equipment necessary to maintain the patient's condition in the short term must be taken by the accompanying staff.

Types of equipment

It must be assumed that the electrical and gas power supply for the hospital will be subject to interruption. All equipment should be battery powered. Because movement leads to haemodynamic instability, equipment to deal with a cardiac arrest should accompany all patients during transit. An extended emergency pharmacy will also be needed to cover the short term needs of patients (e.g. 4-6 hours) by which time alternative safe areas within the hospital would be identified or patients transferred to nearby ICUs. While some forms of therapy cannot be reasonably continued during transfers of this nature (e.g. extra corporeal membrane oxygenation), the need for the therapy in the temporary refuge should also be considered. Many continuous therapies can be stopped (e.g. haemofiltration, parenteral nutrition).

Monitoring equipment

Modern ICU monitoring equipment is usually complex, simultaneously monitoring several physiological variables. It is usually wall mounted, heavy and immobile. During a fire, portable equipment is required. Older stand alone equipment, which may have been superseded by more recent combined monitoring equipment, may be held in reserve for such a use. Other types of equipment, such as a portable suction device and an aneroid sphygmomanometer, may be needed.

Specific equipment required in case of evacuation due to fire

Basic life support
The requirements in case of fire are:

- basic care equipment
- life support equipment
- equipment to detect and treat physiological changes (Table 2).

Basic care equipment
The basic care equipment should be the ICU bed or evacuation stretcher with additional pillows and blankets. Each bed must be equipped with a designated sealed "fire evacuation" box or package, containing a self inflating bag, with reservoir, a size E oxygen cylinder (sufficient for a short journey and at least half full) fitted with reducing valve and flow meter or valve capable of delivering 15 l/min, and a standard single size mask suitable for most ICU patients. This equipment should be checked frequently and at least annually.

Respiratory support
Sufficient portable ventilators are unlikely to be available and under these circumstances the patients will have to be hand ventilated with a self inflating bag. All intubated patients should be attached to a closed breathing system e.g. Waters' bag, or self inflating bag with reservoir, to prevent inhalation of the potentially toxic atmosphere. These should be available at the bedside as part of the fire evacuation box or package. During the evacuation there should be no planned change in the patient's airway management but the equipment for accidental extubation must be on hand (Table 3).

Portable monitoring and treatment
Portable monitoring equipment is needed to detect physiological changes occurring during transit. However, the urgency of the move may preclude performing anything other than simple observation. If more than a single patient is being transferred at the same time, monitoring equipment is likely to be in short supply and may be limited to simple ECG monitoring and pulse oximetry. Infusion pumps are almost invariably battery powered, and can function during transfer. On some occasions, however, a bolus of medication may dispense with the need for a pump, and make for easier movement. Examples of bolus medication include sedatives (morphine, midazolam) and relaxants (vecuronium, atracurium). Some continuous infusions can be discontinued. These could include insulin, anticoagulants, some inotropes. Some may be replaced with alternatives or be changed (e.g. a nitrate patch or buccal preparation instead of an infusion). Nasogastric or enteral nutrition can be stopped. While decisions and planning are taking place, all patients should be ventilated with 100% oxygen until evacuation is underway. It may be appropriate to increase sedation of patients during this stage.

Emergency drugs will be required, as will an extended supply of drugs (Table 4) and other disposables. These are needed to maintain the patients in the hours after a fire, prior to their return to the ICU or transfer to alternative intensive care facilities in an adjacent hospital.

Conclusion

Fire is dangerous but fortunately infrequent. Detection and containment are essential and must be considered in the design of a new ICU or when existing buildings are modified. The serious consequences of fire on the ICU may be reduced by prior planning. This involves an awareness of the hospital's fire policies and procedures, staff training and availability of all necessary equipment.

Each ICU must have a fire safety policy which dovetails into that of the hospital. Staff must appreciate that they may have to make the decisions concerning evacuation of the ICU prior to the arrival of the Fire Service. Once the Senior Fire Officer arrives his instructions should be complied with without question. Through induction courses and regular updates, performance of staff involved in a fire on the ICU will be improved and the risks of disaster minimised.

References

1. NHS Estates. **Hospital Technical Memorandum 83**.
   Fire safety in healthcare premises. General fire precautions. Her Majesty's Stationary Office: London, 1994.

2. NHS Estates. **Hospital Technical Memorandum 81**.
   Firecode: precautions in new hospitals. Her Majesty's Stationary Office: London, 1987.

3. NHS Estates. **Hospital Technical Memorandum 85**.
   Firecode: fire precautions in existing hospitals. Her Majesty's Stationary Office: London, 1994.

4. NHS Estates. **Hospital Technical Memorandum 87**.
   Firecode: textiles and furniture. Her Majesty's Stationary Office: London, 1993.

5. NHS Estates. **Hospital Technical Memorandum 82**.
   Firecode: alarm and detection systems. Her Majesty's Stationary Office: London, 1987.

Table 1

The various types of extinguisher found in NHS premises and their use
From 1997 all new fire extinguishers, irrespective of type, will be coloured red with the appropriate colour banding (the old colour scheme is given in normal text while the new scheme is given in italics). There is no time scale to replace existing multi-coloured extinguishers which may have an effective life span of up to 20 years.

Extinguisher Type	Fire Risk	Typical Sizes (litres or kilograms)
WATER Colour Code = Red *New Code = red band on red body*	**Class A risk.** Solids such as: wood, paper, cloth; for general protection or ordinary combustible materials. Not for use on live electrical equipment	9 l 6 l
FOAM (Aqueous Film Forming Foam) Colour Code = Cream *New Code = cream band on red body*	**Class B risk.** Liquids such as: fats, paint and oil. Also suitable for combustible solid fires (Class A).	9 l 6l
DRY POWDER (Multipurpose) Colour Code = Blue *New Code = blue band on red body*	**Class A risk.** Solids as above **Class B risk.** Liquids as above Also suitable for electrical equipment.	12 kg 9 kg 6 kg 4.5 kg 2 kg 1 kg
CARBON DIOXIDE • Colour Code = Black *New Code = black band on red body*	**Class B risk.** Liquids as above Also suitable for electrical equipment.	5 kg 2 kg
HALON +• Colour Code = Green *New Code = green band on red body*	**Class B risk.** Liquids and electrical equipment. Also suitable for small surface burning fires in combustible solids (Class A).	3 kg 1.5 kg

- • These gases may be dangerous when discharged in an enclosed space with restricted ventilation.
- + The supply of halons is being restricted by an international environmental protection agreement due to their effect on the ozone layer.

Table 2

Categories of equipment for evacuation of critically ill patients from ICU

1	Basic Care (during evacuation)	**ICU bed or evacuation** stretcher, warmth, **comfort (blankets &** pillows).
2	Life Support	**Equipment to maintain:** **- Airway** **- Breathing** **- Circulation**
3	Monitoring Equipment	**Appropriate for the** patient's severity of **illness.** **Portable equipment** may not be **available for each** bed space. Stand alone **monitoring devices** may be needed.
4	Treatment	**Continuing ICU** management. **Emergency treatment** needed during **evacuation.**

Table 3

Equipment required for evacuation of critically ill patients

Airway:

- Laryngoscopes, spare batteries (non-rechargeable), and bulbs
- Catheter mounts
- Disposable humidifiers
- Fixed performance oxygen masks and tubing
- Lubricating jelly
- Artery forceps
- Various sizes of sterile cuffed endotracheal and tracheotomy tubes, and laryngeal mask airways
- Metal and gum elastic introducers
- Tape and adhesive dressing
- Magill forceps
- Airways, oral and nasal (various sizes)
- Suction catheters and suction device

Breathing:

- Portable ventilators if available
- Self inflating resuscitation bags with reservoir
- PEEP valve
- Oxygen tubing
- Oxygen cylinder with appropriate pressure reducing valves for ventilator or low pressure tubing

Circulation:

- Intravenous cannulae (arterial & venous)
- Intravenous fluids, administration sets, three way Luer lock taps & intravenous line extensions
- Pressure bags
- Battery powered infusion pumps with appropriate syringes

Monitoring devices:

- Disposable pressure transducers and pressure infusion bags
- Arterial oxygen saturation
- Temperature
- ECG
- End tidal carbon dioxide concentration
- Anaeroid sphygmomanometer & stethoscope
- Chest drains with either Heimlich valves or underwater drains.
- Documentation (patient's medical notes and "Kardex")
- Syringes, needles, sterile plain and alcohol soaked swabs
- Nasogastric tubes (various sizes)
- DC defibrillator
- Sutures, dressings, scissors, razors, gloves & aprons and other contents of procedure packs

Table 4

Suggested extended pharmacy for critically ill patients

Drugs for continued intensive care	
Sedatives (probably only one or two needed)	Midazolam Diazepam Etomidate Propofol
Neuromuscular blocking agents (probably only one or two needed)	Succinylcholine Atracurium Vecuronium Pancuronium
Cardiovascular drugs	Dopamine Dobutamine Norepinephrine Nitrates Hydrallazine Labetalol Verapamil Amiodarone Furosemide
Bronchodilators	Aminophylline Salbutamol
Opioids (probably only one needed)	Fentanyl Alfentanil Morphine
Emergency resuscitation drugs	Epinephrine Lidocaine Atropine Bicarbonate
Fluids	Crystalloids Colloids (gelatins & starches)