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Fire Safety in Healthcare Facilities: An Indian Perspective

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Abstract

Fire protection and safety measures in hospitals are of utmost importance to ensure the safety of patients, staff, and visitors. Due to the patients' limited mobility, hospitals are more susceptible to fire disasters. Short circuits, basements being used as storehouses, inappropriate storage of flammable liquids, improper power supply load, false ceiling panel lined with thermocol, faulty electric wiring, and overheating leading to burning of wires are some of the common causes of fires in healthcare facilities. Smoke detection systems, sprinkler systems, and the use of fire-resistant materials in hospitals significantly reduce the risk of fire. All measures to prevent and control fire should be taken. Evacuation of patients should be a last resort if the fire becomes uncontrollable. The most significant challenge during evacuation is the movement of patients with mobility issues who require specialized equipment and assistance to move. A properly rehearsed fire action plan is critical to prepare staff for a fire hazard. Regular fire drills, staff training programs, and strict adherence to safety protocols enhance preparedness and reduce response time during emergencies. Periodic inspection and maintenance of electrical systems and firefighting equipment are essential to prevent system failures. Clear signage, unobstructed escape routes, and compartmentalized building design further support effective fire containment and safe evacuation procedures. Hospital management must ensure compliance with fire safety regulations and conduct risk assessments to identify potential hazards. Coordination with local fire departments and emergency services strengthens overall emergency response capabilities. Continuous evaluation and updating of fire safety policies are necessary to address emerging risks and infrastructure changes. Implementing comprehensive fire safety strategies not only protects human life but also safeguards critical medical equipment and hospital infrastructure.

Keywords: Health care facility, fire safety, fire extinguishers, smoke detectors, water

INTRODUCTION

Hospitals are more vulnerable to fire hazards because of a wide range of heat-dissipating equipment, overloading of electrical loads, outdated wiring, use of flammable materials, chemicals, oxygen, and electrical gadgets, lack of fireproofing measures, and firefighting equipment. The non-availability of smoke alarms, water in hydrants, overhead fire water tanks, circuit breakers, emergency exits, and disaster response systems adds to the vulnerability. In addition, the basements in healthcare facilities are generally used as storage areas, and the evacuation passages are often cluttered, further increasing the risk. The excessive use of false ceilings is another predisposing factor for fire hazards in healthcare facilities.

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Hospital fires account for less than 1% of all fires globally but have a fatality rate 2–3 times higher than fires in other buildings due to vulnerable inpatients. The most crucial issue in the case of a fire in a healthcare facility is the evacuation of patients who are not ambulant. All healthcare facilities must comply with fire safety measures

recommended by the National Building Code (NBC) and the National Disaster Management Authority (NDMA). Fire safety measures for the intensive care unit (ICU) and operation theatres are more stringent and need to be strictly followed.

Healthcare fire safety measures differ from those for standard buildings. These include hospital alarm systems that avoid general alerts and are activated as code red to prevent panic among patients. Code red designates a fire emergency in a healthcare facility that requires an immediate staff response. Taller hospital buildings require enhanced fire protection.

FIRE TRIANGLE

The three ingredients that constitute a fire are heat, fuel, and oxygen [1]. Fuel is any combustible material, while oxygen is an oxidizing agent that reacts with the fuel to start and continue the fire. Oxygen and fuel react and must reach a flash point to start a fire. Oxygen-enriched air in a healthcare facility is primarily responsible for many fires, and the ignition energy needed to initiate a fire is reduced in the presence of a higher oxygen concentration; any heat/spark may be the source of ignition [2].

Types of Fires

Class A fires involve solid materials such as wood, paper, and textiles; Class B fires involve flammable liquids; Class C fires involve gases and live electrical apparatus; and Class D fires involve metals [3]. Water is effective in suppressing Class A fires but should not be used for Class B fires.

Fire Action Plan

It comprises prevention, suppression, evacuation, and mock drills [4]. Prevention includes limiting the occurrence of fire incidents and delaying their spread by using fire-resistant materials. Suppression includes fire detection and extinguishing equipment, such as smoke and heat detectors, alarm systems, and fire extinguishers.

Fire Extinguishers

The different types of fire extinguishers are CO_2, dry powder, foam spray, and water [3]. For localized electrical fires, the use of CO_2 fire extinguishers is recommended. For fires other than electrical or oil fires, a water-type fire extinguisher is used. Fire extinguishers are color-coded: red for water, yellow for foam, blue for dry powder, and black for CO_2 [3]. The P.A.S.S. method (Pull, Aim, Squeeze, and Sweep) is a standardized method for operating fire extinguishers effectively in a memorable sequence.

Water Hose Reels

They are generally located on each floor and provide an accessible and controlled water supply connected to stored water for firefighting by the fire service emergency response team.

Water Sprinkler System

It is a network of pipes charged with water, and each sprinkler head is activated once sufficient heat reaches the valve. The sprinkler closest to the fire is activated, providing sufficient water pressure at the fire location. It is less damaging than the water damage caused by water hoses.

Mist Sprinkler System

It has a special nozzle to form dense water mist or fog that removes heat and displaces oxygen from the fire zone and requires low volumes of water [5].

Fire Safety System

It comprises active fire protection, passive fire protection, and life safety components. Active fire protection components include fire tanks, fire hydrants, sprinkler systems, and alarm systems. Passive fire safety measures comprise the vertical and horizontal compartmentalization of buildings into zones to prevent the spread of fire and smoke. Compartmentalization is the process of dividing a building into

sections to limit the spread of fire, smoke, and heat [4]. All fire-check doors must be functional and close automatically, acting as fire and smoke barriers. The life safety component is made up of egress and exit requirements, including staircases, ramps, corridors, and exit sign postings.

Fire Safety Measures

Short-term measures include immediate nonstructural measures focused on creating better preparedness in case of a fire hazard. Preparation of a fire response plan, periodic fire drills, removal of junk lying in the basement, corridors, and fire exits, display of fire signage and evacuation routes in fluorescent colors, availability of smoke extractors and fire protection systems, and putting in place emergency evacuation procedures may be incorporated as short-term fire and life safety measures. Education of staff regarding the use of electrical appliances and equipment, and keeping a limited supply of inflammable liquids in the form of hand sanitizers, needs to be stressed.

Medium-term measures include infrastructural improvements and upgrading of electrical installations after assessing the electrical load. Construction of additional egress routes, use of fire-resistant materials in the interior area of the building, and third-party fire audits need to be planned.

Long-term fire and life safety measures require major infrastructure changes and need to undertake policy-level initiatives for new healthcare facilities to create safer healthcare facilities with integrated fire safety provisions.

False Ceiling and Wooden Paneling

A fine balance must be maintained between aesthetics and fire safety. The use of false ceilings should be avoided; however, if the requirement is inescapable, it should be made of non-combustible material with an appropriate fire rating [6]. Aluminum composite panels (ACP) should not be used as a material for false ceilings. A clear height of 3 m below the false ceiling should be provided, as a lower false ceiling height lowers the smoke height, impairing visibility. Wooden paneling should also be avoided; if used, it should be treated with non-combustible paints and coatings [7].

Curtains and Furniture

Blinds made of non-combustible materials should be used in healthcare facilities instead of fabric curtains. Metal furniture is preferred over wooden furniture.

Mattress, Linen, and Spirits

Foam mattresses create large volumes of smoke in case of fire and need to be replaced with non-combustible and non-smoke-producing materials. Separate fire-resistant enclosures should be used to store linen, cotton, gauze, and flammable liquids.

Evacuation

Evacuation is performed only if preventive and suppression measures fail to contain fire and is generally considered a last resort. Evacuation should be ordered only when necessary and when there is a potential threat to patient and staff safety. It can be a complete or a partial evacuation. Horizontal evacuation involves moving patients away from the threat, keeping them on the same floor [8]. Corridors may be used as temporary safe zones. Vertical threat involves the evacuation of a specific floor. Instructions of ‘shelter in place’ signal staff to remain in their place of duty and defend in place. Defend in place strategy requires fire and smoke resistant enclosures for patients of the ICU and Operation theatre and uninterrupted provision of necessary functional electromedical equipment and medical gases. The three patient evacuation models include geographic, resource, and acuity, based on patient acuity and time available for evacuation. Gradual evacuation happens in a geographic model, units are evacuated sequentially, and it focuses on areas at greatest risk. The resource model gives priority to optimal utilization of resources. In the acuity model, the sickest patients are evacuated last to ensure the greatest good for the largest number of patients. Oxygen tanks must be shut off during evacuations [9, 10].

The staff involved in the evacuation need to be educated about the fireman's lift, blanket removal, removal by stretcher, wheelchair, bed, canvas stretchers, backboards, and skid stretchers. The fireman's lift refers to a physical carrying method for evacuating bedridden patients. Evacuation drills need to be practiced so that patients can be successfully evacuated to a safe place within 2.5 min during fires to avoid smoke and heat hazards. The response protocol includes the R.A.C.E. procedure, which signifies Rescue, Activate Alarm, Contain the spread by closing doors and windows, and Evacuate.

National Building Code 2016

It recommends that corridors in healthcare facilities should have a minimum width of 2.4 m, fire-rated doors for exits, and limited quantities of storage of flammable liquids. The availability of portable fire extinguishers, hose reels, sprinklers, and large water storage capacity is advisable. Other recommendations include illuminated exit signs, unobstructed escape routes, and updated electrical wiring to prevent short circuits.

Ministry of Health and Family Welfare

The Ministry of Health and Family Welfare (MoHFW) guidelines require healthcare facilities to establish fire safety plans, conduct fire risk assessments, and implement fire protection mechanisms. It also directs the need to ensure unobstructed exit routes, have an emergency evacuation plan in place, conduct periodic fire drills, and use fire-resistant construction material.

CONCLUSION

Hospitals are vulnerable to fire hazards. Outdated wiring, use of flammable materials, chemicals, oxygen, and electrical gadgets, lack of fireproofing measures, and firefighting equipment are predisposing factors for fire hazards in healthcare facilities. Fuel, oxygen, and heat constitute the fire triangle. A fire action plan comprises prevention, suppression, evacuation, and mock drills. The appropriate use of fire detection and extinguishing equipment helps to effectively combat fire hazards. The use of non-combustible materials in the interior of buildings is an important preventive measure for fire safety. Evacuation should be ordered only when necessary and when there is a potential threat to patient and staff safety. Fire safety and evacuation drills should be periodically practiced and rehearsed, and firefighting equipment should be periodically maintained.

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