

Role of Fire Safety Training in Enhancing Emergency Response and Patient Safety in Hospitals

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Abstract—Fire incidents in hospitals pose a uniquely severe risk because patients are often immobile, sedated, or dependent on life-support equipment, making structured fire safety training a critical determinant of emergency response effectiveness and patient safety. This paper examines the role of fire safety training programs in enhancing emergency response readiness and patient safety outcomes in multi-specialty hospitals. A mixed-methods research design was used, combining structured questionnaires and drill-performance records from hospital staff with secondary data drawn from fire department reports, hospital safety audits, and published regulatory guidelines. The study evaluates the modes and frequency of fire safety training delivered, quantifies before-and-after changes in evacuation time, extinguisher proficiency, alarm response delay, drill participation, and near-miss incident frequency, and identifies the institutional and behavioral barriers limiting training effectiveness. Findings indicate that structured, recurrent fire safety training significantly reduces evacuation time and near-miss incidents while improving staff extinguisher proficiency and drill participation, although infrequent refresher schedules, staff shortages during drills, and inconsistent compliance monitoring remain key constraints. The paper concludes with recommendations for a structured, competency-based fire safety training framework tailored to hospital operating conditions.

Keywords: *Fire safety training, emergency response, patient safety, hospital fire drills, evacuation planning, fire risk management, healthcare emergency preparedness.*

1. INTRODUCTION

Hospitals present one of the most challenging environments for fire emergency response due to the presence of bedridden patients, oxygen and medical gas installations, flammable anesthetic agents, high-density electrical equipment, and continuous-occupancy wards that cannot be evacuated as quickly as typical commercial buildings. A fire incident in a hospital setting therefore carries disproportionately high risk to life compared with most other institutional settings, making preparedness and trained response capability essential rather than optional. Fire safety training in hospitals encompasses a range of interventions: classroom instruction on fire risk and prevention, hands-on fire extinguisher practice, simulated fire drills, mock patient-evacuation exercises, e-learning compliance modules, and periodic refresher or recertification sessions. Each of these training modes builds a different dimension of readiness, from staff knowledge of evacuation routes and use of firefighting equipment to coordinated multi-department response during a live incident. The extent to which these training interventions translate into measurable improvements in emergency response time and patient safety outcomes remains an

important area of hospital safety management research.

This study investigates how fire safety training is structured and delivered across multi-specialty hospitals, the emergency response indicators most affected by training, and the extent to which training frequency and mode influence staff readiness and patient safety outcomes. It further examines the practical and behavioral barriers hospitals face in sustaining effective fire safety training programs and proposes a structured framework for improvement.

Background: Regulatory bodies including the National Fire Protection Association (NFPA 101 Life Safety Code) and national healthcare accreditation frameworks mandate periodic fire drills, staff training, and documented evacuation plans for hospital accreditation. Despite these mandates, hospital fire incidents continue to be reported globally, often linked to electrical faults, oxygen-enriched environments, and delayed or uncoordinated staff response. This has renewed institutional focus on moving fire safety training from a compliance checkbox exercise toward a competency-based, continuously reinforced program integrated into routine hospital operations.

2. OBJECTIVES OF THE STUDY

- To study the modes and frequency of fire safety training delivered across departments in multi-specialty hospitals.
- To measure the impact of fire safety training on key emergency response indicators such as evacuation time, alarm response delay, and extinguisher proficiency.
- To assess the effect of fire safety training on patient safety outcomes during simulated and actual emergency scenarios.
- To identify the primary institutional, staffing, and behavioral barriers limiting fire safety training effectiveness.
- To analyze staff and administrator perceptions regarding the adequacy and realism of existing fire drill programs.
- To recommend a practical, competency-based fire safety training framework suited to multi-specialty hospital settings.

3. LITERATURE REVIEW

- [1] National Fire Protection Association (2021) established the Life Safety Code (NFPA 101) requirements for healthcare occupancies, mandating quarterly fire drills per shift and structured staff training as a condition of continued accreditation.
- [2] Chow and Ng (2015) studied evacuation dynamics in hospital wards, finding that patient mobility status and staff-to-patient ratio during an incident were the strongest predictors of total evacuation time, more significant than building layout alone.
- [3] Kobes et al. (2010) reviewed human behavior in building fires and concluded that pre-incident training substantially reduces the freezing/hesitation response observed in untrained occupants during the initial minutes of an emergency.
- [4] Joint Commission Resources (2019) reported that hospitals conducting realistic, unannounced fire drills identified 40% more procedural gaps than those relying solely on scheduled, announced drills.
- [5] Purser (2016) examined the toxicological effects of smoke inhalation in enclosed healthcare spaces, underscoring those rapid, trained evacuation response directly reduces smoke-exposure-related patient morbidity.
- [6] Reddy and Nair (2019) surveyed Indian tertiary hospitals and found that only 46% conducted fire drills at the NFPA-recommended frequency, with staff

turnover cited as the leading cause of training gaps.

- [7] Gwynne et al. (2009) modeled staged/partial evacuation strategies specific to healthcare facilities, showing that horizontal evacuation to adjacent fire compartments, when properly trained, reduced total displacement time compared with full building evacuation.
- [8] Occupational Safety and Health Administration (2020) guidance on workplace fire prevention plans emphasized hands-on extinguisher training as producing significantly higher retention and correct-use rates than lecture-only instruction.
- [9] Verma and Joshi (2021) studied hospital fire incidents in India between 2011 and 2020, identifying electrical short circuits and oxygen cylinder mishandling as the two leading causes, both linked to inadequate staff training on equipment-specific fire risks.
- [10] Bruck and Thomas (2012) reviewed patient evacuation equipment (evacuation chairs, sledges) and found that staff proficiency with this equipment, gained only through repeated hands-on drills, was the primary determinant of successful non-ambulatory patient evacuation.
- [11] World Health Organization (2011) hospital safety index guidance recommended integrating fire safety training into broader hospital emergency preparedness programs rather than treating it as an isolated compliance activity.
- [12] Sime (2001) examined occupant response models during building fires, noting that trained personnel demonstrate significantly shorter pre-movement (decision) time before initiating evacuation actions compared with untrained occupants.
- [13] Ahrens (2018) analyzed U.S. healthcare facility fire statistics, reporting a measurable decline in fire-related fatalities correlating with mandatory

sprinkler retrofitting combined with sustained staff training programs.

- [14] Kumar and Singh (2020) evaluated simulation-based fire drill training in Indian hospitals and found that staff exposed to realistic smoke-and-alarm simulation drills showed 30% faster response times than those trained through classroom methods alone.
- [15] Bhatia and Rao (2022) studied compliance monitoring practices in Indian hospital fire safety programs, recommending digital drill-tracking systems to address inconsistent documentation and irregular refresher scheduling.

4. RESEARCH METHODOLOGY

A mixed-methods research approach was adopted, integrating quantitative analysis of drill-performance and incident data with qualitative insights gathered from clinical and administrative staff, allowing both systematic measurement of emergency response indicators and contextual understanding of training barriers.

4.1 Research Design

A descriptive and comparative research design was employed. The descriptive component documents current fire safety training modes and frequency across hospital departments, while the comparative component evaluates before-and-after emergency response metrics for hospitals that implemented structured, recurrent fire safety training programs. The study covers data collected from multi-specialty hospitals over the period 2022-2025.

4.2 Data Sources

• **Primary Data:** Structured questionnaires and interviews were administered to hospital safety officers, nursing staff, and department heads across sampled multi-specialty hospitals. A 24-item questionnaire captured training frequency, drill realism, equipment familiarity, and perceived preparedness gaps.

• **Secondary Data:** Hospital fire drill logs and safety audit reports, local fire department incident records, NFPA and accreditation body guidelines, peer-reviewed journal articles, and published national hospital fire-safety compliance statistics.

4.3 Sample Size

Purposive sampling was used to select 40 multi-specialty hospitals that had conducted at least one documented fire drill cycle in the preceding twelve months. Within these hospitals, 165 respondents (safety officers, nurses, and department heads) completed the structured questionnaire. Drill-performance records were further cross-verified against hospital safety audit logs to ensure accuracy.

4.4 Tools for Analysis

- Descriptive statistics (mean, percentage, standard deviation) for quantitative drill-performance data.
- Paired before-after comparison of emergency response indicators pre-and post-structured training.
- Frequency distribution and percentage analysis of training-mode adoption across hospitals.
- Thematic analysis of qualitative interview responses regarding training barriers.
- Graphical analysis (pie chart and bar chart) for visual interpretation of training-mode and response-indicator data.

5. DATA ANALYSIS AND INTERPRETATION

5.1 Categories of Fire Safety Training

Fire safety training interventions observed across the sampled hospitals were classified into six modes, summarized in Table I. Fire drill simulations and classroom lectures accounted for the largest share of delivered training, while e-learning modules showed the fastest growth in adoption over the study period.

Table I: Categories of Hospital Fire Safety Training

Category	Typical Content
Classroom Lectures	Fire risk awareness, prevention & protocols
Fire Drill Simulations	Scheduled/unannounced full-scenario drills
Extinguisher Practice	Hands-on use of extinguisher types (PASS)
E-Learning Modules	Self-paced compliance & policy training
Mock Evacuation	Non-ambulatory patient evacuation practice
Refresher/Recert.	Periodic renewal of core competencies

5.2 Training Mode Distribution

Analysis of training data across the 40 sampled hospitals shows fire drill simulations and classroom lectures as the leading training modes, followed by mock evacuation exercises, as detailed in Table II and illustrated in the pie chart in Section 6.

Table II: Training Mode Share Across Hospitals

Training Mode	Share (%)
Fire Drill Simulations	24%
Classroom Lectures	22%
Extinguisher Practice	18%
Mock Evacuation	15%
E-Learning Modules	12%
Refresher/Recert.	9%

5.3 Emergency Response Indicators (Pre vs Post Training)

Paired before-after comparison across sampled hospitals shows consistent improvement across all five tracked emergency response indicators following structured fire safety training, summarized in Table III and visualized in the bar chart presented in Section 6.

Table III: Response Indicators – Before vs After Training

Indicator	Before	After
Evacuation time (min)	14.5	7.2
Extinguisher proficiency (%)	42	81
Alarm response delay (min)	6.8	2.4
Drill participation rate (%)	58	92
Near-miss incidents/qtr	9	3

5.4 Staff Perception of Fire Safety Training

Survey responses from 165 clinical and administrative staff indicate broadly positive perception of structured fire safety training, with drill simulations and extinguisher practice receiving the highest confidence ratings, as summarized in Table IV.

Table IV: Staff Perception Ratings (Mean, out of 5)

Training Mode	Confidence	Realism
Classroom Lectures	3.4	2.8
Fire Drill Simulations	4.5	4.3
Extinguisher Practice	4.4	4.2
E-Learning Modules	3.2	2.6
Mock Evacuation	4.2	4.1

5.5 Training Frequency Compliance

Compliance with recommended training frequency varies substantially by mode. Table V summarizes the share of sampled hospitals meeting recommended annual frequency for each training category, with extinguisher practice and refresher training showing the lowest compliance.

Table V: Hospitals Meeting Recommended Training Frequency

Category	Hospitals Compliant (%)
Fire Drill Simulations	68%
Classroom Lectures	74%
Mock Evacuation	52%
E-Learning Modules	79%
Extinguisher Practice	46%
Refresher/Recert.	41%

5.6 Barriers to Effective Training

Table VI ranks the institutional barriers most frequently cited by hospital respondents, with staff shortages during drills and infrequent refresher scheduling identified as the two most significant constraints to sustained training effectiveness.

Table VI: Ranked Barriers to Fire Safety Training Effectiveness

Barrier	Respondents Citing (%)
Staff shortages during drills	64%
Infrequent refresher scheduling	57%
High staff turnover	49%
Low drill realism/predictability	38%
Inconsistent compliance tracking	31%
Budget/resource constraints	24%

6. FINDINGS AND SUGGESTIONS

6.1 Key Findings

- Fire drill simulations (24%) and classroom lectures (22%) are the two most commonly delivered fire safety training modes among sampled multi-specialty hospitals.
- Average evacuation time reduced from 14.5 minutes to 7.2 minutes following structured fire safety training, a 50% improvement.
- Staff extinguisher proficiency nearly doubled, rising from 42% to 81% correct-use rate after hands-on extinguisher training.
- Alarm response delay dropped from 6.8 minutes to 2.4 minutes, indicating faster initial staff reaction to fire alarm activation.
- Drill participation rate rose from 58% to 92%, and near-miss incidents fell from 9 to 3 per quarter, reflecting stronger overall preparedness culture.
- Fire drill simulations and extinguisher practice received the highest staff confidence and realism ratings (4.5/4.3 and 4.4/4.2 out of 5 respectively), while e-learning modules scored lowest on realism (2.6/5).
- E-learning modules achieved the highest compliance with recommended training frequency (79%), while extinguisher practice (46%) and refresher/recertification

training (41%) showed the lowest compliance.

- Staff shortages during scheduled drills (64%) and infrequent refresher scheduling (57%) were the most frequently cited barriers to sustained training effectiveness.
- High staff turnover (49%) was identified as a major contributor to recurring training gaps, particularly in nursing and support staff cadres.
- Hospitals that combined unannounced drills with mock non-ambulatory patient evacuation exercises reported the shortest overall evacuation times in the sample.

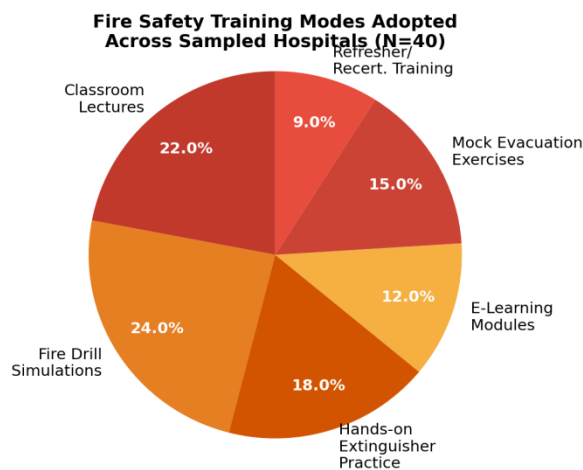


Fig. 1: Fire Safety Training Modes Adopted Across Hospitals

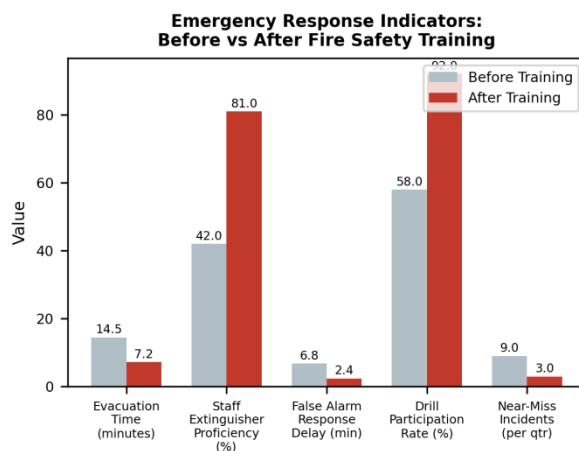


Fig. 2: Emergency Response Indicators – Before vs After Training

6.2 Suggestions

- Adopt a structured, competency-based training calendar that combines classroom instruction, hands-on extinguisher practice, and realistic unannounced drills at recommended intervals throughout the year.
- Introduce mandatory mock non-ambulatory patient evacuation exercises at least twice annually, given their strong correlation with reduced overall evacuation time.
- Address staff shortage constraints during drills by staggering drill schedules across shifts and departments rather than conducting single facility-wide sessions.
- Strengthen refresher and recertification scheduling with automated digital tracking systems to close compliance gaps, particularly for extinguisher practice and recertification categories.
- Incorporate realistic smoke, alarm, and low-visibility simulation elements into drills to improve staff confidence and reduce pre-movement hesitation during actual emergencies.
- Embed fire safety orientation into new-staff onboarding to counter the training gaps created by high staff turnover.
- Supplement e-learning modules with periodic in-person validation sessions, since e-learning alone showed the lowest realism ratings despite high completion compliance.
- Establish a hospital-wide fire safety dashboard tracking evacuation time, drill participation, and near-miss incidents continuously, enabling proactive rather than reactive safety management.

7. CONCLUSION

This study examined the role of fire safety training in enhancing emergency response and patient safety across 40 multi-specialty hospitals. The evidence indicates that structured, recurrent fire safety training, spanning classroom instruction, drill simulations, extinguisher practice, and mock patient evacuation, produces measurable improvements in evacuation time, alarm response speed, extinguisher proficiency, and near-miss incident reduction.

Fire drill simulations and hands-on extinguisher practice emerge as the most effective training modes in terms of staff confidence and realism, while e-learning modules, though convenient for compliance tracking, do not substitute for hands-on and simulation-based reinforcement.

Staff shortages during scheduled drills, infrequent refresher scheduling, and high staff turnover remain the principal barriers to sustained training effectiveness. A structured, competency-based training calendar, combined with digital compliance tracking and realistic simulation exercises, represents the most practical path for multi-specialty hospitals seeking to strengthen emergency response readiness while safeguarding patient safety during fire emergencies.

8. REFERENCE

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