

Evacuation of a Paediatric Hospital Ward in Italy: Lessons Learnt From an Announced Evacuation Drill

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Abstract The process of evacuating a hospital ward is a complex task that involves several challenges related to emergency protocols, such as the need for assisted evacuation, the staff/patient ratio, and the functional limitations of patients. The purpose of this work is to present a possible sequence of events that can take place during an evacuation drill in a paediatric hospital ward. This is deemed to provide guidance in performing such type of drills and investigate assisted evacuation timelines. The drill was conducted inside a paediatric ward in Italy, at that time closed for maintenance, with the help of figurants emulating paediatric patients. The medical personnel were the ones normally working inside the facility. The activity was video recorded and summarised in a written report. This allowed the analysis of the drill and the reconstruction of typical set of events and timelines that take place in such type of evacuation drill scenarios.

Keywords Evacuation · egress drill · Hospital · assisted evacuation · functional limitations

1 Introduction

Hospital facilities contain equipment and installations that can lead to incidents such as fires, chemical and biological emissions or electromagnetic radiation. Fire emergency procedures include technical and medical personnel dealing with fire containment and relocation of the occupants from danger. In this context, evacuation procedures involve moving the residents from the ward towards safety, so called assisted evacuation [1]. Fires in healthcare facilities have been investigated in the literature. For example, Huang et al examined six fires [2]. In these events, the main victims were patients. This tendency is attributed to their limited self-evacuation abilities, which makes them vulnerable in fire scenarios. From the analysis of the reported cases, the researchers identified the fire- and evacuation-related risks that place the greatest burden on the fire safety management system. For the fire risks they identified: multiple and diversified combustibles, complex electrical circuits with strong electricity demand, improper management of fire protection facilities and human factors. For evacuation-related risks they found: the large number of evacuees, unfamiliarity with the hospital environment, varying walking abilities, human response under emergency conditions, limited space for evacuation in corridors, complicated evacuation routes and long vertical distance. In another paper, thirteen fires characterised by a large number of fatalities were analysed [3]. The study highlights that one way to improve life safety in such scenarios is an efficient fire safety management system, including staff training and evacuation drills. A review of recent incidents in healthcare facilities in the Italian context (see Tab. 1) showed that the majority of the reported events did not have any major consequences other than the closure of the premises or departments concerned. On the other hand, casualties and injuries also occurred in some instance.

In an international context, US data from the three-year period 2012-2014 published by the US Fire Administration (USFA) reported 5700 cases of fires within healthcare facilities, 1100 of which are within hospitals [5]. A further consideration can be made with the German data compiled by the Bundesverband Technischer Brandschutz e. V. (BVFA), an association of manufacturers of fire-fighting equipment and systems, which recorded 96 fires during the year 2022 [6]. This report, although not exhaustive, indicates a steady increase in fires since the start of the monitoring activity. Similar data are published by the British government's Home Office, which indicates the number of fires that occurred inside hospitals and healthcare facilities during the financial years (6th April to 5th April of the following year), starting in 2010 [7]. The document reports a total of 543 cases in the year 2022, of which 211 were linked to arson, resulting in one fatality and 39 injuries. An analysis of data from previous years shows that the trend is downward (from 700-900 cases in the 2010-2015 time interval to an average of 500 cases during the last three years). Finally, data by Fire and Emergency New Zealand dated 2018 shows an average of 168 recorded cases per year in 10 years of fires occurring in hospitals, hospices, nursing homes, rehabilitation centres, clinics and medical centres. The average figure is in line with the last reported figure for the year 2017 of 152 cases. Evacuating a hospital is certainly a complex operation presenting many issues linked to emergency procedures, the need for assisted evacuation, staff/patient ratio, functional limitations of patients, etc.;

Event	Causes
Papardo Hospital, Messina, 22/01/23	A drug addict attacks some doctors and starts a fire with a lighter or a cigarette, setting three bags of plastic waste on fire outside the dumpster because they are full.
Conegliano Hospital, Treviso, 01/02/23	Short circuit to a pulmonary respirator being charged.
Sacco Hospital, Milano, 17/02/23	Malfunction of a neon lamp in the cardiology department.
Sant'Elia Hospital, Caltanissetta, 09/03/23	Causes not ascertained.
Cannizzaro Hospital, Catania, 09/03/23	A psychiatric patient set fire to a roll of toilet paper in the emergency room bathroom.
Guido Compagna Hospital, Corigliano Rossano, 12/03/23	A patient undergoing compulsory medical treatment set fire to a stretcher with a lighter. It should be noted that the fire detection and alarm system was not activated in this event.
Dell'Angelo Hospital, Venezia, 15/03/23	A psychiatric patient set fire to the bed sheets.
Pertini Hospital, Roma, 25/05/23	Short circuit in the electrical panel inside a maintenance area, involving plastics covering some materials.
Ecclesiastico Miulli Hospital, Acquaviva delle Fonti, 1/07/23	Short circuit (ignition object not specified) in the basement floor.
Santa Maria Goretti Hospital, Latina, 13/07/23	Fire triggered in the CED room.
San Martino Hospital, Genova, 19/07/23	Short circuit of a power supply in the resuscitation department.
Raimondi Hospital, San Cataldo, 13/08/23	Malfunction of an electrical outlet in a room where CT scans are performed and where some electrical equipment is recharged.
San Paolo Hospital, Civitavecchia, 26/10/23	Fire triggered by a maintenance battery of operating block equipment.
Civico Hospital, Codogno, 20/11/23	Fire of two lockers containing patients' clothes. Causes not ascertained.
Giuseppe Mazzini Hospital, Teramo, 7/11/23	In an outdoor technical area, sparks caused by a grinding wheel used at a construction site ignited a surrounding plastic storage area.
Santa Maria Annunziata Hospital, Bagno di Ripoli, 10/11/23	Fire of a metal box containing medical waste. Causes not ascertained.
San Giovanni Evangelista Hospital, Tivoli, 08/12/23	Blaze started from the pile of garbage outside the building.

Table 1 Hospital fires in Italy in 2023 adapted from Mancin [4].

therefore, a carefully thought evacuation plan is a needed step to address these issues [8]. In this context, evacuation drills (announced, semi-announced or unannounced) can play a useful role in 1) assessing the current evacuation procedures in the hospital and 2) providing training [9]. The purpose of this work is to present a set of lessons learnt from a (relatively simple) announced evacuation drill performed in a paediatric unit of a hospital (see Fig. 1). This allowed investigating the behaviour of the ward operators involved (paediatrics staff) while managing the evacuation of the patients (figureheads) present in the hospital area affected by the simulated fire. The aim is to highlight the procedural issues and the limitations of simple announced evacuation drills and present lessons learnt concerning evacuation test procedures in hospital areas.



Figure 1 Corridor of the paediatric unit of the hospital.

2 An announced evacuation drill

In this exercise, the fire was assumed to develop from an electrical apparatus in one of the rooms of the paediatric ward (see Fig. 2). Only one patient per room is admitted to the operating unit under consideration. To represent the usual working conditions in the rooms, there were a total of 3 bedridden patients with the following characteristics: 1 patient with suction connected to the monitor (room 1), 1 patient connected to oxygen (room 2) and 1 patient with continuous infusion on the pump in progress (room 3). The paediatrics staff involved was composed of two nurses, one on-duty operator and 2 doctors. The start of the event was triggered by a simulated ignition of the monitor placed at the side of the patient 1. One of the operators noticed the smoke (a sign with a flame was placed during the simulation) caused by the fire and alerted the staff, informing them about the event, its extent, the presence of patients and the location concerned. The ward staff proceeded to alert the others in the vicinity to set up emergency management measures (closing room doors and fire doors), to relocate the patients and organise their tasks, and to lead them to the identified safe area, gradually closing the fire doors behind them. In the scenario, the situation inside the room is assumed to be such that the staff, having acknowledged the extent of the event, will have to evacuate the patients to safety. The ward staff evacuated the patients to the nearest safe place (progressive horizontal evacuation) and remained near to coordinate the operations with the staff on site. The emergency was declared closed once the patients had been transported to the indicated safe place. Tab. 2 and Fig. 3 show the evacuation timeline.

Event
1 Start of the evacuation drill. The start of the fire is simulated by placing an identification sign (flame with smoke) on the monitor in room 1.
2 Staff become aware of ignition in the vicinity of the patient, and verbally alert the staff, who quickly rush in the room.
3 The on-duty operator dials the emergency number.
4 Two nurses open the windows of room 1 and start the procedures to evacuate the patient 1 connected to the monitor. The operators open the windows (shutter down), disconnect the monitor from the power supply and start with the evacuation of the patient.
5 The first patient is relocated to the safe place and the door of the room is closed to contain the smoke; the on-duty operator remains with patient 1 to provide assistance.
6 Two nurses open the windows of room 2 and start the procedures for evacuating patient 2 connected to oxygen. The attendants open the windows (vasistas while keeping the shutter down), disconnect the patient from the oxygen supply system and start with the evacuation of patient 2.
7 The operator initiates the internal emergency procedure (i.e. this includes all persons, systems and means aimed at preventing and protecting workers from occupational risks).
8 During the movement of patient 2, the staff stops at the hospital infirmary in the middle of the corridor to retrieve an oxygen cylinder and connect it to the patient's bed. Immediately afterwards, patient 2 is carried through the door of the compartment and connected to the oxygen cylinder. The door to room 2 (not directly affected by the fire) is closed.
9 The patient in room 2 reaches the safe place; the on-duty operator stays in the designated safe place to assist patients 1 and 2.
10 A nurse, later assisted by a second nurse, opens the windows of room 3 and starts the relocation procedures of patient 3 connected to the pump. The nurse disconnects patient 3 from the pump and starts the patient's relocation.
11 Patient 3 is taken out of the room and one of the nurses opens the room windows and closes the room door.
12 Patient 3 is also taken past the door in the safe place.
13 The door beyond which the patients were taken is closed.
14 End of the evacuation drill.

Table 2 Sequence of events during the evacuation drill.

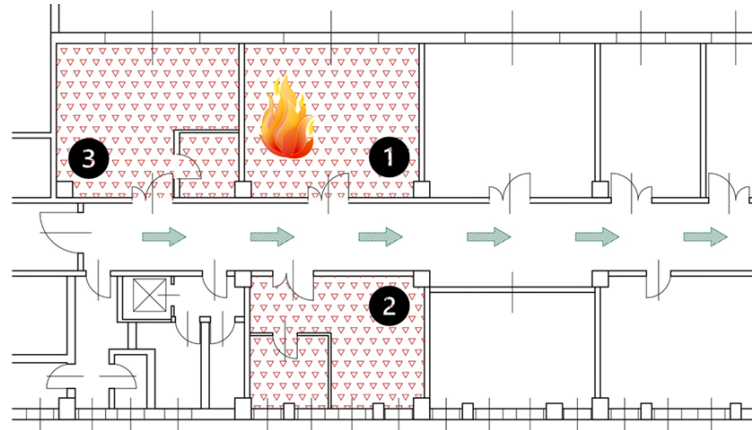


Figure 2 Schematic top view of the paediatric unit of the hospital including room 1,2 and 3 where the assisted evacuation took place. The fire was in room 1.

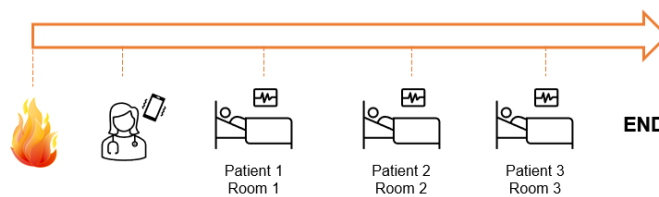


Figure 3 Event timeline.

3 Conclusion

The evacuation of a hospital ward is a complex undertaking that encompasses several issues associated with emergency procedures, the need for assisted evacuation, staff/patient ratio, and the functional limitations of patients. The objective of this study was to conduct an evacuation drill inside a hospital ward in Italy and present an example of simple procedural training. The timeline of events presented is deemed to be a useful guideline to perform similar efforts in hospital wards. The first limitation of this study relates to the use of figures rather than real patients during evacuation drills in hospitals. In this specific case, hospital wards (especially a paediatric one) hosts family members; it would be therefore appropriate to investigate in drills the increase in occupant load and associated social influence. The impact of considering announced vs unannounced simple evacuation drills concerning assisted evacuation in hospital wards should also be considered, ranging from feasibility and practical aspects to the validity of the behaviours observed. The case study concerns a paediatric unit, a particularly complex scenario when it comes to plan for assisted evacuation. Just recently, more than 15 babies in neonatal intensive care units (NICU) were evacuated in a hospital fire in Ottawa. Lessons learnt during evacuation drills can include the identification of mismatches between the expected procedures in place and the actual evacuation performance. This is particularly relevant for facilities where staff reports to have limited training on evacuation procedures [10]. Overall, this work is deemed to represent a starting point towards a better understanding of the advan-

tages and limitations of simple procedural evacuation drills in paediatric hospital wards in which assisted evacuation takes place.

In conclusion, based on the analysis of the drill [4], valuable insights and recommendations can be highlighted for the design phase of emergency simulations in a hospital setting. Prior to initiating the design, it is crucial to clearly identify the intended purpose of the drill. This may vary depending on the organizers' specific needs. Possible purposes include 1) evaluating the existing conditions of locations, facilities, and equipment; 2) assessing the staff's knowledge of emergency procedures; and 3) providing training. Furthermore, during the design phase, it is imperative to determine the participants and their numbers, considering factors such as potential overcrowding, individuals with special needs (e.g., people with mobility limitations), and types of occupants (such as patients, visitors, contractors). Designing an evacuation drill without specifying an incident scenario may undermine its effectiveness. The choice of the drill scenario may be in line with evacuation design or common threats. Lastly, to address issues arising from the drill, it is essential to collect information on the course of events. This can include placing observers at relevant locations or recording of behavioural activities, ultimately facilitating understanding the evacuation process.

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