Abstract

This paper illustrates a study conducted into the managerial practices implemented to mitigate the consequences of a major fire emergency and to promptly restore normal business operations at a large pediatric hospital. Stemming from prior research on crisis response and recovery in critical infrastructures, this investigation demonstrates that factors such as the complexity of the underlying stakeholder networks, the vulnerability of the involved actors, and several temporal and spatial constraints, all contribute in hampering the intervention of crisis managers. In these situations, relying on consolidated best practices may enable more rapid response and more adequate recovery.

This study adopts a qualitative approach to build a retrospective case study that highlights the crucial issues that healthcare crisis managers are requested to face when exposed to thorny work conditions: presence of numerous actors from the public and the private sector, involvement of organizations with contrasting interests, need for a balance among public health, cost containment and legitimacy, etc. The findings of the present investigation expand the theoretical knowledge on the dynamics that characterize crises occurring at critical infrastructures and provide practical recommendations for healthcare emergency managers to improve their response to, and recovery from, major fire emergencies.

Keywords

Crisis management, Fire emergency, Pediatric hospital, Healthcare emergency management.

1. Introduction

Extensive academic literature has been dedicated to the evaluation of emergency response plans in a variety of industries and events, such as natural hazards (An, Bai, Xu, Nie, & Wang, 2015; Bisri, 2013), nuclear (Ten Hoeve & Jacobson, 2012), industrial (Krausmann, Cozzani, Salzano, & Renni, 2011; Lindøe, Engen, & Olsen, 2011; Wei & Lu, 2015) and transport accidents (Carim Jr et al., 2016; Fan, Li, Pei, Li, & Sun, 2015). A burgeoning field of research, emergency management in the healthcare sector deserves further attention by researchers and practitioners, in order to diffuse best practices and reduce costs of accident prevention and response (Alves, Cagliuso, & Dunne, 2015; Lakbala, 2016; Orlando, Danna, Giarratano, Prepas, & Johnson, 2010). As critical infrastructures, modern hospitals are vital systems whose incapacitation *'[…] would have a debilitating impact on national security, national economic security, national public health or safety, or any combination of these.'* (Sullivant, 2007, p. 538). As a consequence, the amount of disaster planning and emergency preparation that modern hospitals are required to develop is significant (Bish, Agca, & Glick, 2014).

The complexity that underlies healthcare operations in hospitals, coupled with the risks associated with an emergency, makes evacuations particularly delicate for emergency managers in the healthcare sector. During emergencies, complexity of operations in hospitals is exacerbated by a number of factors: presence of vulnerable patients (classified by severity and health conditions), presence of potentially dangerous substances (e.g., chemical and radiological) and the need for the evacuees to be constantly assisted. Furthermore, an acknowledged, natural proneness by the healthcare sector to be posed under strict scrutiny by the media (Wilmar, Ahlborg, Jacobsson, & Dellve, 2014) has the potential to exert further pressure on healthcare emergency managers. Natural hazards (earthquakes, floods, hurricanes, etc.) or human actions (deliberate or unintended) have in the past caused hospitals to implement their emergency plans in order to minimize risks for patients and staff members (Chavez & Binder, 1996; Schultz, Koenig, & Lewis, 2007; Sternberg, Lee, & Huard, 2004). Such emergency plans are based on a structured approach.

The American Society for Healthcare Risk Management (ASHRM) identifies four steps that are involved in emergency management in healthcare facilities: *prevention, planning and preparation, implementation and response* and *recovery* (Carroll, 2010). In the initial *prevention* phase, emphasis is placed on building robust internal reporting systems to detect early warnings of potential crises. In the *planning and preparation* stage, the emergency managers ensure that adequate emergency plans are effectively designed and maintained. In the *implementation and response* phase, the emergency plans are deployed and a first reaction to the events is provided. In the final *recovery* stage, financial, operational and psychological measures are taken in order to restore pre-crisis conditions.

The following table 1 summarizes several significant studies that have explored the different stages of the healthcare emergency management process, and provides an overview of their main focus areas and findings.

Author(s), year	Type(s) of threat	Focus	Stage(s)	Main findings
(Achour, Pascale, Soetanto, & Price, 2015)	All	Emergency plans	Planning and preparation	UK healthcare emergency planning needs further integration of 'soft' and 'hard' resources.
(Bish et al., 2014)	All	Evacuation models	Implementation and response	A model to evacuate critical patients in an emergency situation.
(Chavez & Binder, 1996)	Earthquake	Treatment of mass casualties	All	Emergency planning in hospitals is effectively complemented by training, communication and resource allocation.
(Chien, Yu, Huang, & Chong, 2011)	Fire	Information systems	Recovery	Real-world testing of a web-based information system to effectively enhance business continuity after an emergency.
(Chowdhury, 2014)	Fire	Root cause analysis	Prevention	Indian hospitals need to improve their handling of O2 in order to prevent fire risks.
(Cone & Koenig, 2005)	Chemical, biological, radiological, nuclear	Treatment of mass casualties	Implementation and response	Elaboration of chemical, biological, radiological, or nuclear-compatible trauma triage algorithms.
(Hertzberg, Blomqvist, & Tuovinen, 2007)	Fire	Toxicity indicators	Prevention	In Swedish hospitals, requirements for flooring materials should be the same as walls and ceiling to prevent toxic contamination in case of fire.
(Moore, Geller, & Clark, 2015)	Chemical, radiological	Treatment of mass casualties	Planning and preparation	Recommendations to help hospitals prepare for chemical and radiological emergencies.
(Niska & Shimizu, 2011)	All	Emergency plans	Planning and preparation	In the US, hospitals are less prepared for explosive and incendiary incidents than for chemical, natural and biological events.
(Schultz et al., 2007)	Earthquake	Evacuation models	Prevention	Peak ground acceleration is a superior risk indicator than distance from the epicenter for hospitals affected by earthquakes.
(Sternberg et al., 2004)	All	Evacuation models	Implementation and response	An overview of US hospital evacuations 1971-1999 highlights that more than 50% of cases originated for internal hazards, not for natural disasters.
(Wetter, Daniell, & Tresser, 2001)	Chemical, biological	Emergency plans	Planning and preparation	In general, US hospital emergency departments are not prepared to treat victims of chemical or biological attacks.

Table 1: Synthetic review of healthcare emergency management literature

Research demonstrates that American healthcare facilities are more covered against other types of hazards than fire events (e.g., radiological, chemical, and nuclear attacks, biological accidents,

epidemics and pandemics) (Niska & Shimizu, 2011). An extensive body of academic studies in healthcare emergency management focuses on the aforementioned threats (see, among others, Cone & Koenig, 2005; Moore et al., 2015; Wetter et al., 2001). As illustrated in Table 1, academic research on healthcare emergency management seems to predominantly concentrate on other threats than fire events. Furthermore, the first two stages of the emergency management process, *prevention* and *planning and preparation*, attract most of the attention in the literature.

Based on this overview, the scholarly literature needs additional, comprehensive studies exploring the effectiveness of *implementation and response* and *recovery* plans executed by healthcare facilities, especially in situations of fire emergencies. Recent research (Lu, Mei, Wang, & Zhang, 2012) shows in fact that fire events in hospitals and healthcare facilities are usually associated with high fatality levels due to the relatively high vulnerability and low physical ability of their occupants. In the United States, the National Fire Protection Association has compiled an exhaustive report on the features of fire events in healthcare facilities (Ahrens, 2012). This report indicates that, on average, in the period 2006 – 2010, the US fire departments responded to 6,240 fire events per year in healthcare facilities. These caused an annual average of around six deaths, 171 injuries among civilians, and more the 52 million USD in property damage. Despite this, surprisingly, in 2008 less than 80% of hospitals in the US had emergency plans for explosive or incendiary incidents (Niska & Shimizu, 2011).

Notwithstanding the scarce number of studies exploring the characteristics of fire emergencies in healthcare infrastructures, several exceptions exist. In their investigation on the recovery of fire-damaged medical equipment, Chien, Yu, Huang and Chong (2011) illustrate the case of a fire event that occurred in a Taiwanese hospital and resulted in extensive damage to critical medical equipment. The researchers provide an overview of the disaster recovery process implemented after the event and emphasize the important support that appropriate web-based information systems can provide in maintaining adequate levels of care. Hertzberg, Blomqvist and Tuovinen (2007) investigate an arson hospital fire which occurred in Sweden and identify a number of factors that contributed to the event. Among these, besides the perpetrator's deliberate act, the presence of easily ignitable materials in the mattresses and the flooring of the hospital's bedrooms facilitated the diffusion of fire, smoke and toxic substances. The investigation conducted by Lu, Mei, Wang and Zhang (2012) applied the correspondence analysis technique to high-casualty fire data in China. This study highlights the associations between fatality levels and influence factors such as affected infrastructures, causes, time, month, year and location. The results demonstrate that fires in healthcare facilities tend to be strongly associated with high-fatality levels, especially when the origin of the fire event is task-related

(e.g., negligence by operators), the fires occur in the daytime during the cold months, and the fires affect facilities located in highly-populated areas (e.g., Beijing).

This review of the academic literature emphasizes the need for researchers and practitioners to further analyze the nature and characteristics of fire events developing in healthcare and assistance facilities. As previously discussed, these events have the potential to yield a higher number of casualties, when compared to other accidents and infrastructures (Lu et al., 2012). In order to address this acknowledged gap in the literature, the present paper explores a major fire event that occurred at a large pediatric hospital in Rome. The main objective of this article is to share an experience of emergency response and recovery from a fire event that affected a hospital operating in thorny conditions. Focus of the present paper is on the *response* to, and *recovery* from, a fire event that occurred at the *'Bambino Gesù'* hospital (OPBG) in November 2010 ("Bambino Gesú" Hospital, 2010b).

1.2 The Hospital and the Fire Event

The *'Bambino Gesù'* (OPBG) is a Catholic, pediatric hospital and research center owned by the Vatican City, established in 1869 ("Bambino Gesú" Hospital, 2015b). The hospital, which started as a room with four beds, is nowadays one of the largest pediatric hospitals and research centers in Europe. The OPBG is accredited under Joint Commission International, an independent organization that evaluates quality and patient safety in global health care (Joint Commission International, 2017). The hospital currently boasts occupancy of approximately 600 beds. Its occupancy rate was around 91% in 2015. It has almost 2,600 staff members (in 2015, around 20% were contract workers) and each year provides over 1 million healthcare services to children and adolescents from all over the world ("Bambino Gesú" Hospital, 2015a).

Operations at the OPBG have been constantly expanding in the last years, as demonstrated in Table 2 below:

Activity	2010	2011	2012	2013	2014	2015	Difference (10-15)
Hospitalizations	23,778	25,057	26,319	26,770	27,342	27,336	14.9%
Consultations	1,001,882	1,131,264	1,139,450	1,411,517	1,589,080	1,639,658	63.6%
Emergency visits	59,113	63,121	70,911	72,744	77,232	78,849	33.3%
Surgeries	20,427	21,943	25,815	28,131	28,300	26,166	28.1%

Table 2: Operations at the OPBG ("Bambino Gesú" Hospital, 2012, 2015a)

On November the 5th 2010, at 3.10 pm, the Intensive Care Unit (ICU) located in *'Pio XII'* pavilion, first floor, was affected by a fire emergency. A nurse had noticed smoke coming from the

head physician's room. At that moment, *'Pio XII'* pavilion hosted 55 patients, 9 of which were in the ICU. A total of 82 staff members were employed in the affected building. The security and the first response team were alerted and immediately reached the ICU. The Vatican City Fire Brigade and the Italian Fire Brigade were also alerted (3.20pm) and reached the hospital premises at 3.25pm and 3.35pm. In the meantime, the hospital's first response team, following the indications contained in the emergency plan, started assembling the fire hoses, which the Vatican City Fire Brigade then connected to their fire truck. The fire was extinguished before 3.35pm, but the smoke kept spreading and reached the nearby Pediatric Pathology ward and the stairs of the building. It took 20-25 minutes to completely evacuate the two involved wards (ICU and Pediatric Pathology) and fully contain the emergency. No major injuries resulted from the event, but many pieces of equipment were damaged due to the high temperature, the smoke, the ashes and the electrical short circuits generated by the water from the sprinklers and the hoses. A report elaborated by the Vatican City Fire Brigade, and confirmed by the Italian Fire Brigade, indicated that the fire event was likely caused by an electrical short-circuit that affected a computer in the head physician's room (Vatican City Fire Brigade, 2010).

2. Research Methods

This paper aims at providing an overview of the ways in which modern, large-scale hospitals can manage a fire event by implementing an effective emergency management plan. To do so, a single case study approach is adopted. Case study research consists of a detailed exploration that attempts to provide an analysis of the context and processes involved in a phenomenon under investigation (Yin, 2009). A case study methodology is appropriate when contemporary events are analyzed, when the boundaries between these and the context are not entirely clear, and when organizational, social and political phenomena are investigated (Yin, 2009). Most important, case study research is mainly exploratory and particularly useful when used to study underexplored concepts such as the response and recovery stages of a fire emergency in a large healthcare facility. This investigation utilized a retrospective case study methodology, in which data were collected after the analyzed event had occurred; researchers had access to both primary and secondary data sources; and an illustration of the chain of events that characterized the fire emergency under study was possible at the moment of the research. A retrospective case study design is particularly suitable to examine an extreme case that has a distinctive value (Street & Ward, 2010) such as a fire emergency in a pediatric hospital, a critical instance of healthcare emergency management.

In order to nurture the case study, this investigation mainly utilized two methodologies: document analysis and informal interviews. As for the former, the most important source of information was constituted by an internal report elaborated by the Enterprise Risk Management

department of the hospital ("Bambino Gesú" Hospital, 2010b). Information contained in this document was drawn from the informal interviews conducted in the days following the event, together with technical reports produced after the emergency. Data on the case were also drawn from other organizational documents such as the Emergency and Evacuation Plan (EEP), the Risk Assessment and Management Plan (RAMP), the Corporate Improvement Plan (CIP), the Italian and Vatican City Fire Brigades technical inquiries, damage assessment technical reports, and several legal and organizational procedure manuals. Articles from three newspapers were also used to provide further information on the events.

Eighteen informal interviews were conducted by members of the hospital's Prevention and Protection Service with people directly or indirectly involved in the event, in the timeframe 5 – 24 November 2010. Interviews revolved around the perceptions that respondents had on the response and recovery phases of the event. Table 3 illustrates the sample of interviewees. Due to the confidential nature of the information provided, personal identities (e.g., names, job titles, etc.) are not disclosed. Interviewees were recruited via email, based on their presence at the moment of the fire and their involvement in the response and recovery stages. Official investigations by the Police and the Fire Brigade to assess responsibilities in the event were ongoing at the moment of the interviews, which could not be recorded. However, interviewers were able to take notes on the responses provided by the participants. As previously mentioned, data collected during the interviews were utilized by members of the Prevention and Protection Service to produce the internal report ("Bambino Gesú" Hospital, 2010b).

Organization	Department	Number of interviewees (function)
OPBG	ICU	1 (admin.) – 4 (doctor/nurse)
OPBG	Pediatric Pathology	1 (doctor/nurse)
OPBG	Traumatology	2 (doctor/nurse)
OPBG	Surgery	2 (doctor/nurse)
OPBG	Security	3 (first response)
OPBG	Maintenance	1 (supervisor)
Italian Fire brigade	-	2 (manager)
Contract organization	Cleaning	1 (supervisor)
Contract organization	ICU	1 (doctor/nurse)

Table 3: Sample for the informal interviews

Document analysis was mainly utilized to gather data about the chain of events that characterized the fire event, the response and the recovery stages. Informal interviews were primarily used to explore the perceptions of the protagonists on the same stages. Both sources of data were also utilized to provide an assessment of the performance of the response to, and recovery from, the fire

emergency. In particular, the official Fire Brigade technical inquiry and the damage assessment technical report provided relevant information on this last point.

Once collected, data were prepared for analysis. The researchers surveyed the documents to be included in the document analysis and verified the completeness of the available material. Data analysis was then executed by identifying recurring themes. The first level of analysis utilized the four stages of emergency management in healthcare facilities identified by the American Society for Healthcare Risk Management (ASHRM) (Carroll, 2010) to isolate the *implementation and response* and *recovery* actions executed by the OPBG. The second level of analysis focused on each of the two stages and provided a taxonomy of sub-stages for effective healthcare emergency management. These taxonomies are reflected in the structure of the results section of the present paper (Section 3).

As a qualitative piece of research, this paper is assessed against the four criteria of *credibility, transferability, dependability* and *confirmability* (Lincoln, Lynham, & Guba, 2011; Shenton, 2004). First, *credibility* of the present investigation is ensured in three ways (Patton, 2002): by applying rigorous methods described in detail in the present section of the paper; by leveraging the credibility of the researchers involved in the informal interviews, subject matter experts belonging to the Prevention and Protection Service of the OPBG; and by adhering to a philosophical belief in the value of qualitative research. Second, given the limited *transferability* of findings from which case studies typically suffer, the present paper itemizes in detail the adopted methodology, in order to provide a blueprint for other researcher to replicate it (Shenton, 2004). This was achieved within the methodological boundaries imposed by the retrospective approach adopted in the study, which focused on an extreme case with a distinctive value. Third, *dependability* indicates that a study obtains the same results when repeated under the same conditions. In order to overcome the limitations intrinsic to qualitative research, this investigation was conducted with a robust case study protocol (data collection and analysis methodologies follow best practices in qualitative research), elaborated around a sound case study database (Yin, 2009), composed by the variety of information sources reported in the present section. Fourth, *confirmability* (or objectivity) of the research was achieved by providing both *within method triangulation* (using different documents for the data analysis, such as technical reports and newspapers articles) and *across method triangulation* (informal interviews integrated information that was drawn from document analysis) (Yin, 2009).

3. Results

3.1 Implementation and Response Stage

The *implementation and response* stage to the fire emergency was ensured by the OPBG managers by activating the emergency plan and executing specific actions, aimed at mitigating the immediate impact of the emergency. These actions were dictated by the Emergency and Evacuation Plan (EEP) in effect at the moment of the fire event ("Bambino Gesú" Hospital, 2010c). The EEP illustrates in particular the pathways to be taken to reach the nearest emergency exit. Furthermore, the EEP provides the layout of the fire prevention system, with details on the location of sprinklers, extinguishers, hydrants, hoses, etc. According to the EEP, the fire emergency procedure is initiated through these steps:

- Warning procedure: in presence of an imminent danger (e.g., smoke, flames, explosions, collapses, leakage of flammable substances, etc.) any staff members phones security and provides details of the event (e.g., location, features, etc.); simultaneously,
- First appraisal procedure: the trained staff members initiate a first assessment of the emergency;
- Reception of the warning: security requests detailed information about the event and contacts the first response team;
- First response: any staff members involved in the emergency execute the first response activities, which include: establishing if the fire can be managed with the nearby equipment; assist people in life-threatening conditions; close fire doors to contain smoke, heat and flames; count staff members and patients; provide clear information to the patients and their families; etc.

Response to the fire event was characterized in particular by the following sub-stages, identified as recurring themes in the collected data: Patient Evacuation, Management of Fire-Exposed Rooms, Patient and Family Support, Monitoring of Fire-Exposed Workers, Contamination Tests and Insurance Inspections/Damaged Equipment.

Patient Evacuation. At the moment of the fire event, in the ICU there were two doctors, 7 nurses, a clerk assistant, a healthcare assistant, 9 young patients and some parents of the patients who were in a waiting room close by. As the smoke infiltrated the whole ward, bag valve masks were utilized to transfer 8 patients to other wards on the same floor. The remaining patient had more complex needs as she required dialysis and artificial respiration. She was therefore kept in her room with her doctors and parents until safe conditions for evacuation were established. All the ICU

patients and staff members were safely evacuated without anyone suffering from extensive smoke inhalation ("Bambino Gesú" Hospital, 2010b).

Management of Fire-Exposed Rooms. Eight wards and units in the building exposed to the fire were temporarily redirected into other facilities of the OPBG. Due to the immediate use of backup technology, assistance to critical patients was ensured and basic life services were maintained (Isman, 2010). Damage directly caused by the fire was limited to the head physician's room and a few surrounding rooms. Further damage was indirectly caused by the fire: the combustion of PVC pipes and electric cables released corrosive chlorides which extensively contaminated part of *'Pio XII'* pavilion. Additionally, minor damage was caused by the use of water from the fire hoses, in particular to the floors below. The following figures 1 and 2 illustrate the damage caused by the fire (Vatican City Fire Brigade, 2010).

Figure 1: Corridor of the ICU after the fire event (photo by Vatican City Fire Brigade)

Figure 2: Head physician's room after the fire event (photo by Vatican City Fire Brigade)

In order to secure the building, pavilion *'Pio XII'* was temporarily locked down. This pavilion suffered from significant damage not only due to the fire, but also because of the smoke contamination. Given the nature of the environment, all contaminated material had to be removed and verified for integrity. Access was temporarily prohibited until the building was secured by means

of specific interventions. These interventions are summarized in Table 4 below ("Bambino Gesú" Hospital, 2010b).

Management of Fire Exposed Rooms	Location
Collapsing walls and false ceilings demolished	ICU
Water used to extinguish the fire dried by means of fans	ICU and wards below ICU
Temporary protection devices put on damaged windows	ICU and Pediatric Pathology
Air Handling Units (AHU) filters substituted	ICU and Pediatric Pathology
Integrity of technological equipment (PCs, phones, faxes, servers, etc.) verified	ICU and Pediatric Pathology
Fire prevention devices (extinguishers, gas masks, fire hoses, etc.) replaced	*'Pio XII'* pavilion
Affected furniture removed and securely stored	ICU and Pediatric Pathology
Drugs, disposables and medical devices affected by the fire or contaminated by the smoke removed and securely stored	ICU and Pediatric Pathology

Table 4: Interventions to Manage Fire-Exposed Rooms

In order to preserve the ongoing, normal business operations at the Hospital, the day after the event, wards in *'Pio XII'* pavilion were reorganized and moved to other locations within the precinct. A total of 91 hospital beds were relocated within two days, as Table 5 below indicates ("Bambino Gesú" Hospital, 2010b).

Ward	Beds	Pre-event location	Post-event location	Date
Intensive Care Unit	8	*'Pio XII'* pavilion, 1st Floor	Ground Floor, OBI-DEA[1]	6th November
Neonatal Pathology	15	*'Pio XII'* pavilion, 1st Floor	Second Floor, *'GPII'* pavilion	6th November
Perinatal emergency therapy	3	*'Pio XII'* pavilion, 2nd Floor	Ground Floor, OBI-DEA	6th November
Immature	12	*'Pio XII'* pavilion, 2nd Floor	Second Floor, *'GPII'* pavilion	6th November
Neonatal Surgery	15	*'Pio XII'* pavilion, 3rd Floor	Second Floor, *'GPII'* pavilion	6th November
Neurotraumatology	2	*'Pio XII'* pavilion, 3rd Floor	Second Floor, *'Ford'* pavilion	6th November
Hepato-gastroenterology	14	*'Pio XII'* pavilion, 4th Floor	Second Floor, *'S. Onofrio'* pavilion	7th November
Pediatrics II	22	*''GPII''* pavilion, 2nd Floor	Fourth Floor, *'Pio XII'* pavilion	8th November

Table 5: Relocation of Affected Wards

Patient and Family Support. After the fire event, the physical wellbeing of patients and families was addressed as the absolute priority. No major injury was caused to anyone by the fire

[1] OBI: *Intensive Short Observation* (Osservazione Breve Intensiva); DEA: *Emergency and Triage Department* (Dipartimento di Emergenza ed Accettazione).

(ANSA, 2010). In the days following the event, eight critical patients were transferred to other hospitals in Rome, due to the reduced capacity of *'Pio XII'* pavilion (Il Messaggero, 2010). In order to address the psychological issues related to the accident, two days after the fire event an emergency *speak up* was activated by the Health Management Office. In particular, items lost by the patients and their families during the fire were classified and, where possible, salvaged. Free accommodation was provided to single mothers and fathers that had their children hospitalized. Psychologists activated a support service and provided free assistance to the affected families ("Bambino Gesú" Hospital, 2010b).

Monitoring of Fire-Exposed Workers. Apart from the patients and their families, some 50 people involved in the fire event required medical attention over the following days ("Bambino Gesú" Hospital, 2010b; Isman, 2010). Their wellbeing was monitored by a special service provided by the OPBG. In some cases, people were hospitalized in external facilities. Post-traumatic disorders were monitored. OPBG staff members, doctors, nurses, security and first response team staff involved in the evacuation, contract workers, etc. only had minor health issues (nausea, headache, cough, heavy respiration, etc.). These resulted in sick leaves ranging from zero to 7 days, with an average of 2.7 ("Bambino Gesú" Hospital, 2010b). However, psychological issues (e.g., insomnia, phobia and nightmares) lasted longer and affected more intensively those that more actively participated in the emergency and the subsequent evacuation.

Contamination Tests. A fire in an environment containing plastic materials rapidly develops contaminants which can damage any type of equipment. When the temperature reaches around 300 degrees, 80% of the chlorine contained in the polyvinylchloride (PVC) has already been released in the surrounding environment (Saeed, Tohka, Zevenhoven, & Haapala, 2005). Furthermore, hydrochloric acid is produced by the reaction between the chlorine and the water utilized to extinguish the fire. Current practice indicates the following limits for chlorine contamination: 5μg/cm² in case of electrical systems and 10μg/cm² in case of iron parts ("Bambino Gesú" Hospital, 2010a).

At the OPBG, the fire burnt the PVC of which the floors, the equipment and the electrical systems of the affected wards were made. In order to assess the presence of contaminants resulting from the fire, *quick tests* were conducted on equipment, machinery and devices in the affected rooms. Table 6 below illustrates the most relevant measurements that emerged from the *quick tests.*

Item	Location/Description	Test results
1	Neonatal Pathology – 1st floor – Fire area	Total destruction of equipment, machinery and devices
2	Neonatal Pathology – 1st floor –Room 3 – Vertical surface	5-10 μg Cl/cm^2
3	Neonatal Pathology – 1st floor –Room 3 – Patients monitor	5-10 μg Cl/cm^2
4	Neonatal Pathology – 1st floor –Hallway- Electric dashboard	15/20 μg Cl/cm^2

5	Neonatal Pathology – 1st floor –Hallway- Furniture	<5 µg Cl/cm^2
6	Neonatal Pathology – 1st floor –Room 2 – Nozzle A/C	15/20 µg Cl/cm^2
7	Basement - Dialysis device	15/20 µg Cl/cm^2
8	Basement –Blood refrigerators	5/10 µg Cl/cm^2
10	Perinatal emergency therapy - 2nd – Hallway - Electric dashboard	<5 µg Cl/cm^2
12	Perinatal emergency therapy - -2nd –Incubator doctors room	5/10 µg Cl/cm^2
14	Perinatal emergency therapy - -2nd – Lift door	5/10 µg Cl/cm^2
15	Neonatal Surgery - -3rd – Hallway - Electric dashboard	No pollution
16	Neonatal Surgery - -3rd – Hallway –False ceiling	No pollution
18	Internal surface AHU n. 34	>20 µg Cl/cm^2

Table 6: Contamination Quick Tests Results

Insurance Inspections and Damaged Equipment. A managerial task force was organized the day after the fire in order to make the compensation process quicker and more effective. All key-competencies were grouped in the Task Force, under the supervision of the Enterprise Risk Management General Manager: Enterprise Risk Management, Technical Services, Medical Engineering, IT Systems, Legal Office, Logistics, Budget, Forensic Scientist, and Human Resources. Furthermore, an external, technical consultant was hired to assist the OPBG in the damage evaluation and compensation. A total of 544 units of medical equipment were damaged by the fire, by the contaminants or by the water utilized to extinguish the fire ("Bambino Gesú" Hospital, 2010a). These included artificial respiration units, incubators, dialysis equipment, defibrillators, nitric oxide units, monitors, personal computers, printers, etc.

The aforementioned pieces of equipment were inspected and classified as follows:

1. Destroyed or irreparable – to be replaced (9 units)
2. Reparable, but life-supporting – to be replaced (also in case of restoration, as the manufacturer did not guarantee their reliability, 221)
3. Reparable, non-life supporting, whose restoration was cheaper than replacement – to be restored (85)
4. Reparable, but whose restoration was more expensive than replacement – to be replaced (93)
5. Third-party equipment – no action taken (136)

Particular attention was also paid to economic losses stemming from the temporary suspension of healthcare services. However, these losses were not covered by any insurance. This last point was addressed in the recovery stage, as discussed in section 3.2.

3.2 Recovery Stage

The fire event was an occasion for the OPBG to learn from experience and activate measures to improve safety and security in the hospital precinct. At the moment of the fire, an upgrade of the hospital facilities was being carried out, according to the pre-existing Hospital Strategic Plan. The emergency described in this paper provided further momentum for the implementation of an

improved version of such plan ("Bambino Gesú" Hospital, 2010b). In order to restore the pre-emergency situation and implement more effective crisis management instruments, post-emergency recovery was carried out through the following activities: Improvement of Fire Protection Systems, Improvement of Communications Systems, Training of Employees and Contract Workers against Fire Emergencies, Improvement of Emergency Vehicle Access, Fire Safety Training for Fire Brigade, Customization of the Emergency Plan to Radioactive Substances, Improvement of the Insurance Policy, Development of an Occupational Health and Safety Management System and Implementation of a Healthcare Risk Management Plan.

Improvement of Fire Protection Systems. The fire detection devices existing at the hospital at the moment of the emergency differed substantially in terms of employed technology. Over the years, several refurbishment works took place in the different areas of the OPBG. As a result, at the time of the fire, the fire alarms could not be simultaneously monitored from a single location but had to be directly inspected on site, as they were being activated. After the event, the existing fire protection systems were improved by means of more modern technologies. The old, non-centralized fire alarms were substituted by a new, centralized system that monitors all alarms in a unique, man-manned control room.

Improvement of Communication Systems. The fire event highlighted some weaknesses in the existing communication system ("Bambino Gesú" Hospital, 2010b). During the evacuation, the high number of emergency calls made, from inside and outside the hospital, originated congestion in the landlines. This forced the First Response Team to use the hospital telephone exchange system, which slowed down rescue operations. Also, mobile communication was hampered by the number of incoming phone calls. In order to address these issues, priority phone call models were organized and specific communication slots were allocated within the hospital telephone exchange system in case of emergency. Furthermore, the First Response Team members were provided with walkie-talkies, in order to ensure a more direct and coordinated communication than the mobile phones.

Training of Employees and Contract Workers against Fire Emergencies. Overall, staff members involved in the accident response and recovery demonstrated adequate preparedness to deal with the fire emergency ("Bambino Gesú" Hospital, 2010b). In the days following the event, the Secretary of the Vatican State paid tribute to *'…the competence and dedication of the personnel of the OPBG and the Fire Brigades, who […] made it possible for all the patients to be rescued with no harm'* (Il Messaggero, 2010, p. 2). The report elaborated by the Enterprise Risk Management department of the hospital ("Bambino Gesú" Hospital, 2010b) highlighted two areas for improvement: first, some of the fire doors between the ICU and the stairwell were not properly closed by the personnel of the First Response team; second, some of the workers involved in the event

entered the already evacuated rooms once these were completely filled with smoke, which could potentially hamper, and not facilitate, the emergency response. The OPBG decided therefore to enhance its investments to improve workforce training in the field of risk management ("Bambino Gesú" Hospital, 2010b). Conversely, issues about the level of training were identified for some contract workers employed in the First Response Team (nurses, healthcare assistants, technicians, etc.). Thus, cooperation among the different employers and contract workers involved in the First Response Team was improved and specific Fire Safety training organized. Moreover, specific clauses to make Fire Safety training compulsory (either provided by the contract workers' employers or by the OPBG in exchange for adequate savings) were established in all work contracts.

Improvement of Emergency Vehicle Access. Given the location of the OPBG, at the heart of a busy area in Rome, traffic has always been a problem around the hospital. During the fire event, firefighters struggled to access the OPBG, due to several illegally parked cars on the square in front of the building. After the event, OPBG management officially required the Municipality of Rome to strengthen their patrols in that area. Local Police was also asked to improve vertical and horizontal road signs ("Bambino Gesú" Hospital, 2010b).

Fire Safety Training for Fire Brigade. One of the issues that emerged from the event was the unfamiliarity with the facilities of the OPBG by some firefighters. Especially the less knowledgeable ones experienced some disorientation when they accessed the hospital buildings during the fire evacuation ("Bambino Gesú" Hospital, 2010b). This resulted in slower operations. In order to address this issue in the post-event phase, the OPBG started organizing regular fire safety drills at the hospital buildings involving the local Fire Brigade.

Customization of the Emergency Plan to Radioactive Substances. The fire event described in the present paper did not involve the radioactive substances present in the hospital (for therapeutic, diagnostic and research purposes). Despite this, concern was raised by the emergency about the threat represented by the release in the atmosphere of radioactive substances following a fire event. For this purpose, the OPBG elaborated a specific emergency plan to manage an accident involving radioactive substances. Training of First Response Team members and OPBG employees was strengthened to face such an emergency ("Bambino Gesú" Hospital, 2010b).

Improvement of the Insurance Policy. After the event, changes were made to the insurance policy covering activities at the OPBG in order to: 1) extend the coverage to the economic losses resulting from suspended healthcare activity in case of emergency; and 2) cover for third-party goods, equipment and devices, not covered at the moment of the fire. Furthermore, a clause in the insurance policy was added to link the premium to improvements made by the OPBG in the field of risk prevention.

Development of an Occupational Health and Safety Management System. The fire event boosted the implementation of a new Occupational Health and Safety Management System (OHSMS) by the hospital. Purpose of this new OHSMS was not only to fulfill administrative requirements established by law, but also to achieve specific goals in public health and safety (e.g., reduction of costs associated with OHS accidents and risks; increase of efficiency and effectiveness; and improvement of internal and external reputation).

Implementation of a Healthcare Risk Management Model. The OPBG launched a study on the implementation of a Healthcare Risk Management model. Purpose of this model was to improve the hospital's preparedness to emergencies by addressing case-specific issues in healthcare management ("Bambino Gesú" Hospital, 2010b).

3.3 Perceptions on the Fire Event

The official enquiries conducted by the Fire Brigade and the magistrate did not result in criminal charges against the hospital. Secondary data can be utilized to further elaborate on the general public's opinion around the crisis response and recovery. In an interview granted to the Italian press agency ANSA, the then-mayor of Rome declared: *'It's been a real miracle. […] The good news is that all the emergency services worked really well, in a coordinated fashion, the Civil Protection Agency and the Fire Brigades, the Police, the Carabinieri*[2]*, as well as the great response capabilities of the hospital's personnel. Their quick and effective response has avoided a tragedy.'* (ANSA, 2010, p. 2, authors' translation). A woman, interviewed by the newspaper La Repubblica (Isman, 2010, p. 2, authors' translation), declared that the response provided by the hospital's personnel *'was quick, so that the worst consequences could be avoided.'*. The relatives of some patients expressed their concern about the fact that at the moment of the event they did not hear the fire alarm: *'I was on the stairs […] I was there when […] the children were taken outside. I did not hear the fire alarm, neither did I notice water coming out, as one would expect. […] Several parents declared they did not hear the alarm.'* (ANSA, 2010, p. 1, authors' translation). On the same issue, a father declared the following: *'I did not hear the alarm either. I believe that if the fire alarm of such a big infrastructure went off, it would have been heard across the whole Rome.'* He nonetheless conceded the following, on the circumstances of the emergency: *'Obviously, everything happened in a situation of great personal excitement, and I cannot be absolutely certain that I haven't missed something.'* (ANSA, 2010, p. 2, authors' translation).

[2] The *Carabinieri* is an Italian law enforcement agency under the Ministry of Defense, with similar competences to the Police.

4. Discussion

The present paper illustrates the steps accomplished by a pediatric hospital in responding to, and recovering from, a major fire event that occurred in one of its wards. This process was not free from hurdles. Apart from an acknowledged propensity for organizational crises intrinsic to large-scale healthcare facilities (Hollnagel, Wears, & Braithwaite, 2015), several critical features characterize the OPBG. First, as a pediatric hospital, the OPBG hosts young patients with very different clinical records and a broad spectrum of treated pathologies. Second, the hospital's occupancy rate is usually very high (see Section 1.2). Third, the hospital's business model implies high presence of contract workers on site, with different duties and contractual arrangements (see section 1.2). Fourth, given the age of the patients, there is constant presence of parents and family members on the premises, also overnight. Fifth, given the hospital's location at the heart of a busy residential area, also the buildings surrounding the hospital facilities are characterized by high occupancy rate. Lastly, even though the hospital lies on Italian soil, is subject to the Vatican City jurisdiction. This translates into jurisdictional complexity and may potentially jeopardize quick response in case of accidents. Considered altogether, the aforementioned characteristics of the OPBG generate institutional complexity and potential for organizational vulnerability (Lukasik, 2003). These critical features are associated with physical (geographic location), institutional (pediatric hospital treating a number of pathologies), business model (presence of contract workers and high occupancy rate) and regulatory characteristics (Vatican City jurisdiction). The combination of these factors presents a threat to effective emergency response and recovery. In the explored case, organizational complexity translated into fragmented communication systems, uneven fire detection coverage and sub-optimal levels of training. This had an impact on the response and recovery stages of the emergency, although it did not compromise their effectiveness.

4.1 Implementation and response stage

Literature shows that organizations that effectively learn from past emergencies enjoy a greater deal of *resilience*, in that they develop the potential for avoiding future crises or being prepared when these occur (Smith, 2005). In the healthcare sector, resilience has been defined as *'the ability of an organization to adapt to pressures and still produce good outcomes.'* (Hollnagel et al., 2015). This definition implies that, in order to be considered resilient, healthcare organizations such as hospitals should enhance their adaptive capacity (ability to react to pressures) to produce good outcomes, with a focus on learning and adaptation (Barach & Johnson, 2006). Immersed in the complexity of the healthcare industry, workers need to be able to safely adapt to an environment that constantly changes, and in which linear cause-event-consequence processes are often impossible to

ascertain (Ross & Anderson, 2015). The fire event described in the present paper illustrates the importance that business continuity management has for healthcare organizations, an aspect also emphasized in the literature (Devlen, 2009). Intended as *'a decision-making process aimed at minimizing business loss and maximizing business recovery'* (Geelen-Baass & Johnstone, 2008, p. 162), an appropriate business continuity management system strengthens an hospital's resilience in the face of disasters. The present case study focuses on the implementation and response and recovery stages of healthcare emergency management as identified by the AHSRM (Carroll, 2010). Specific business continuity management components have been indicated to align to the emergency management phases (Devlen, 2009), in particular *plan activation*, *emergency response and operations*, *incident command* and *emergency operations centers*. After an initial assessment of the fire event, the OPBG personnel activated the EEP (implementation) to initiate the reaction to the fire event (response). *Patient evacuation* constituted the most compelling priority for the emergency personnel, as well as the first step to ensure business continuity for healthcare operations. The affected wards were relocated within two days following the event. Although slowed down in some cases, normal operations at the OPBG could be maintained with no major hindrance. Only the Emergency Department was declared temporarily closed (until 9am of the following day), in order to prioritize assistance to the people involved in the fire event (Il Messaggero, 2010). Response to the fire event was then completed by focusing on the remaining three categories of subjects affected by the emergency: the families of the patients, the workers and the physical assets. As for the first two categories, the response of the OPBG was organized around providing psychological (emergency *speak up*) as well as physical assistance (free accommodation for the parents of the patients), according to best practices acknowledged in the literature (Devlen, 2009). As for the management of the physical assets damaged in various ways by the event (fire, heat, water, chemicals, etc.), the OPBG immediately initiated the removal process, as well as the contamination tests to verify the extent of the chemical contamination. This part of the response stage merged into the inspections executed for insurance purposes, which eventually resulted in the hospital negotiating new insurance policies to cover for a broader spectrum of economic losses deriving from similar accidents.

The role of parents and relatives of the patients in the response phase of the emergency constitutes an interesting topic for further discussion. On the one hand, in fact, as demonstrated by research conducted on a similar accidental event (Hunte, 2015) supplementing the prescribed emergency response system with additional support from other providers allows the flexibility that an hospital needs to 'fill the gaps' and effectively respond to an emergency. In the case described in the present paper, parents and relatives of the patients at the OPBG actively contributed to the evacuation, as witnessed by the following excerpt: *'In those moments, we all tried to help, many*

mothers and nurses carried the children to take them to a safe place' (Isman, 2010, p. 2, authors' translation). On the other hand, the fire event at the OPBG seems to contradict scholarly literature that indicates how parents of children undergoing specific treatments have the potential to facilitate systemic resilience in case of emergency. Schubert, Wears, Holden and Hunte (2015) illustrate the case of the mother of a patient treated for cancer who also needed to undergo a dental procedure. When the dental nurse approached the young patient to floss him, the mother stopped her, remarking that her son's blood count for the day was unknown, and using the floss could have had adverse consequences on him. The authors underline how parents of children undergoing specific treatments (in this case, for cancer) have a great involvement in their children's health conditions and are able to anticipate, monitor, and recover from, dangerous situations. The contrary was experienced during the response stage of the fire event at the OPBG. During the rescue operations, several people witnessed instances in which mothers of young patients attempted to frantically pull off drip-feeds and oxygen tubes from their children in order to carry them away. Doctors and nurses were seen yelling at them not to do so (Isman, 2010). In this case, in spite of the mothers' genuine intentions, their involvement in the emergency operations made them over-react to the circumstances, at the risk of jeopardizing the well-being of their children, who needed to be evacuated in safe conditions.

Time is one of the most compelling issues with emergency management in healthcare critical infrastructures, as demonstrated in a number of eminent cases reported in the literature (Bish et al., 2014; Schultz et al., 2007). The literature defines response time as the *'time required by the emergency services to reach the incident point after getting incident information'* (Bandyopadhyay & Singh, 2016, p. 138). In the case of healthcare facilities, the presence of personnel specifically trained to face large-scale emergencies, is meant to reduce the response time and enable an effective reaction to the crises before the arrival of dedicated emergency services. In spite of the presence of qualified staff, emergency response at the OPBG was naturally hampered by the location of the precinct, situated in a particularly congested neighborhood of Rome. Response time was also increased by the presence of several vehicles illegally parked on the path of the Fire Brigade. In spite of this, once alerted, the Vatican City Fire Brigade managed to cover the distance to the OPBG (around 3 km) in only 5 minutes. The Italian Fire Brigade provided additional services and reached the hospital (around 5 km distance) in less than 10 minutes.

4.2 Recovery stage

In terms of emergency recovery, the fire event at the OPBG epitomizes some of the crucial capabilities that complex healthcare organizations need to deploy to build their resilience (Hollnagel et al., 2015) and in particular *learning*, *anticipation*, *monitoring* and *response*. Several measures taken

in the post-emergency phase witness the organizational learning process that the OPBG has implemented since the fire event: the identification of sub-optimal emergency management practices at the moment of the fire (e.g., non-centralized fire alarms, gaps in the communication systems, difficult access to the precinct by the emergency vehicles, etc.) has been followed-up by related improvements. These contribute in the direction of *anticipating* a similar event in the future and *monitoring* its consequences (e.g., by defining an emergency plan specific for radioactive substances; by creating a centralized control room for fire alarms; etc.) and improving the *response* capabilities of the hospital (e.g., by harmonizing internal communication systems). Another improvement can be ascribed to the *learning* category of counter-measures to build organizational resilience. In the area of training, the OPBG has taken steps to harmonize the ways in which safety training is delivered to all workers employed in the hospital precinct, including contract workers. In the risk management literature, institutional complexity is often indicated as a source of vulnerability that has the potential to lead to major crises (Lukasik, 2003). In this scenario of complexity, the effectiveness of safety best practices can be down-watered by the contractual arrangements in place in organizations. Managerial supervision is less effective when different companies work together and responsibilities are not always clear. In order to face this issue, after the fire event, the OPBG implemented stricter contractual provisions, for example by including specific clauses for fire safety training. On a similar note, in order to attract additional energies to deploy in case of emergency, the hospital strengthened its collaboration with the local city council to improve vehicular traffic management around the precinct.

4.3 Challenges in Emergency Management

Assessing the effectiveness of the emergency management activities delivered in response to a major accident in a large-scale critical infrastructure is a difficult exercise. It requires a mix of benchmarking techniques, standard assessment criteria, quantitative information around losses and costs associated to a disruptive event, and qualitative data about the perceptions of the involved actors. For various reasons, the present retrospective case study lacks some of the aforementioned components of a solid performance measurement instrument. However, some performance-related remarks on the response and recovery activities executed during and after the fire event that affected the OPBG can be made. Boin and ‘t Hart (2010, p. 380) identify a number of challenges typically faced by incident commanders and operations managers in crisis response. *Diagnosing and deciding* refers to the situational awareness necessary to initiate the crisis response process, based on available information (often incomplete) and under time pressure, in a constantly changing environment. Once informed of the fire, the First Response team of the OPBG immediately initiated the procedures

required by the EEP, which constituted a regulatory instrument supporting decision-making in conditions of extreme uncertainty (about the extent and development of the fire, etc.). *Mobilising and organising* refers to the quick solicitation and the orderly deployment of the available operational resources to face the crisis. The timely implementation of the EEP contributed in activating the different organizational components responsible for dealing with the emergency (i.e. nurses and doctors, security and First Response team, etc.). Evacuation was carried out at full speed, with some disruption caused by the excitement of parents and relatives of the patients and the mix with the emergency services (*'…there were flames, and amidst the general panic somebody broke the glasses to let the smoke out. In these streets there was an impressive back and forth of ambulances…'* (Isman, 2010, p. 1, authors' translation). *Containing and mitigating* involves reducing the impact of the threat, which in the case described in this paper was possible due to the combined action of the OPBG personnel and the quick intervention by the Fire Brigades (the fire was extinguished in less than 25 minutes since smoke was first noticed). *Informing and empowering* refers to the need for involved organizations to adequately inform the relevant stakeholders of the crisis and its consequences. The prompt response to the emergency demonstrates that the chain of command in place at the moment of the fire well functioned, despite some drawbacks in the communication systems. Mobile and landline phone communication experienced congestion, which somehow slowed down the emergency response activities ("Bambino Gesú" Hospital, 2010b). For similar reasons, the equipment utilized by the First Response team during the crisis (e.g., mobile phones) did not allow an immediate information exchange among its members. As highlighted in the findings of the present study, the OPBG has addressed these areas for improvement. Data collected during the present investigation only marginally refer to the crisis communication activities carried out by the OPBG in the recovery stage (e.g., the *speak up* service implemented by the hospital), an area worth further exploration. The final crisis management challenge identified by Boin and 't Hart is *coordinating and collaborating* and refers to the need for crisis managers to make sure involved organizations (public and private) effectively collaborate in facing the emergency. This case emphasized some limitations in the crisis response, which can be attributed to the variety of institutional arrangements that the organizations involved in the fire event had. An example of this is the gap in training requirements that some contract workers involved in the First Response team had. In the recovery phase, the OPBG strengthened its collaboration with the contracted companies to ensure adequate levels of training on emergency management were delivered.

4.4 Research limitations

Due to the research design embraced in this investigation, the present study has some methodological limitations, two of which are associated with the adopted approach, a retrospective case study. First, this investigation was conducted after the critical event occurred, which could generate a *recall effect*, with interviewees inaccurately recalling the order of the events (Street & Ward, 2010). However, the impact of this limitation was contained by concluding the interviews no later than 19 days after the fire. Second, retrospective case studies have the potential to produce a *spoiler effect* (Street & Ward, 2010), in which the investigators, aware of the outcomes of the critical event, could unintentionally overemphasize aspects of the data analysis and support specific conclusions or hypotheses. In order to address this potential limitation, the research team triangulated primary sources of information (interviews) with secondary ones (analysis of organizational documents) and extensively documented the research process. Further confirmation of the findings of the present investigation was drawn from other secondary sources such as the official Fire Brigade technical inquiry, the damage assessment technical report and newspaper articles on the event.

A further limitation of the present study resides in the fact that the research team could not record the informal interviews after the event. This was due to the circumstances that characterized the event, which entailed extensive investigation by the Police and the Fire Brigade. Given the retrospective nature of the case study, researchers preferred to immediately collect data from people involved in the event rather than waiting for a more formal interview process to be set up. This reduced the latency from the event to the recount and minimized the *recall effect* that could arise (Street & Ward, 2010). The data emerging from the informal interviews were collected by the research team and synthesized in the internal report ("Bambino Gesú" Hospital, 2010b) which constituted the basis of information for the present paper. Furthermore, in order to leverage ease of access to respondents that had been involved in the fire, interviewers were members of the Prevention and Protection Service of the hospital. A final research limitation relates to the fact that parents and relatives of the patients could not be directly interviewed. Secondary data were nonetheless drawn from newspaper articles that reported some of the parents' and relatives' perceptions around the fire event.

5. Conclusion

This case study has emphasized how complex critical infrastructures, such as a pediatric hospital, can effectively respond to, and recover from, a major crisis, demonstrating that indispensable degree of resilience that healthcare facilities typically need. Adopting a retrospective case study approach, this investigation has explored the interventions implemented at the OPBG on the occasion

of the fire that affected one of its most critical wards (the ICU) in November 2010. Focus of this research was in particular on the post-emergency stages, when resilient organizations manage to learn from past crises in order to be able to anticipate, and mitigate the consequences of, future ones. The fire event illustrated in this paper did not claim human life, but resulted in a number of injuries and post-event conditions treated in the weeks following the emergency. The potential impact on public health and the economic damage resulting from the event have demonstrated the importance for modern hospitals as critical infrastructures to master emergency management techniques. In an institutional context where involved actors belong to different organizations (public and private altogether), the supervisory role played by healthcare managers has a growing relevance. Constant training, outstanding safety track records and enhanced situational awareness become unavoidable in a sector under constant media scrutiny. Furthermore, the economic dimension of modern hospitals is gaining growing relevance, especially in terms of sustainability of operations and investments in research. As the present case demonstrated, a well-managed emergency can not only reduce human and economic costs, but also boost improvement in Healthcare Risk Management.

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