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# Boston Marathon Bombings: Hospital Readiness and Response

## SUMMARY

This Lessons Learned document provides an examination of local hospital readiness and response efforts after the Boston Marathon bombings on April 15th, 2013. Hospitals in Boston relied on response plans, training, and coordination between facilities to save over 140 lives after the bombings.

## DESCRIPTION

On April 15, 2013, two improvised explosive devices (IEDs) detonated near the finish line of the 117th Boston Marathon, approximately three hours after the winners completed the course. The first IED explosion occurred at 2:49 pm Eastern Daylight Time (EDT) and the second took place 13 seconds later.

Both IEDs consisted of pressure cookers concealed in backpacks with low-grade explosives and nails, shards of metal, and ball bearings. The devices were 200 yards apart, near the metal barriers that separated the spectators from the runners.[1]

At the time of the explosions, approximately 17,000 runners had completed the race while 9,000 more were still advancing toward the finish line.[2] The explosions occurred in the last 225 yards of the course, near a large number of spectators, resulting in 3 deaths and 264 people injured. The scale of the incident required local, state, and federal partners to carry out a coordinated multi-agency response. Hospitals treated over 140 victims during the aftermath of the incident. All of these victims survived.

### *Hospital Readiness*

The Boston Marathon bombings produced a high number of casualties that could have overwhelmed area hospitals and exceeded their capacity to treat victims.[3] Comprehensive response plans and previous training facilitated Boston hospital staffs' ability to manage the surge of patients and avoid exceeding their capacity to treat patients in need of emergency care.

### Plans

Recent incidents, such as the 9/11 attacks and the Aurora, Colorado shooting, spurred hospital officials to consider and prepare for mass casualty incidents (MCIs). In order to coordinate an effective response effort in the wake of an MCI, Boston hospitals created or enhanced their response plans. Planning for an MCI incorporates a comprehensive approach to consider a multitude of scenarios and involves a thorough assessment of local conditions and coordination with community stakeholders.[4] The Boston hospitals' response plans familiarized hospital staff with their roles and responsibilities during an MCI. This enabled staff to coordinate effectively with on-scene responders to receive and treat a sudden surge of patients with life-threatening injuries, as demonstrated during the response to the Boston Marathon bombings.

Upon notification of an MCI with patients soon to arrive, hospital staff must effectively and efficiently transfer from day-to-day procedures to emergency response operations. Transferring to emergency response procedures requires all participating staff to think quickly and perform many non-routine tasks. Emergency response to an MCI also involves possibly making significant changes to procedures.[5] In response to the Marathon bombings Boston hospitals performed the following after activating their emergency plans:

- Hospital staff relocated patients to clear the emergency department, prepared operating rooms, and pre-positioned trauma teams. The incident commander for the emergency department coordinated the clearing of emergency rooms and the mobilization of staff and equipment. Hospitals also alerted their Radiology Departments to ensure the availability of technicians and equipment, such as CT scanners and X-ray units. Massachusetts General Hospital (MGH) suspended routine CT scans in order to have them available for bombing victims and asked technologists to standby with portable imaging units.[6]

- Hospital response plans incorporated measures to respond to a radiation or chemical release following an MCI.[7] Many Boston hospital staffs have experienced treating battlefield wounded and have trained for cases where the possibility of radiation or chemical contamination was a concern. These experiences have influenced planning. Therefore, Boston hospitals now incorporate these concerns into their response plans.[8] For example, in accordance with their response plans, once Brigham and Women's Hospital (BWH) began to respond to the Boson Marathon bombings, personnel prepared HAZMAT decontamination units.[9]

- Hospital response plans accounted for the possibility of an attack on the facility and incorporated additional security measures to prepare for such an event. Therefore, once hospitals activated their response plans after the Marathon bombings, hospitals reinforced security measures by positioning additional law enforcement onsite and remaining on high alert for suspicious activity.[10] According to Julia Compton, a Registered Nurse in the Emergency Department at Tufts Medical Center, "we had to evacuate our department in the middle of [emergency department operations] because there was a bomb scare." Following the blasts, hospital security staff identified a suspicious package that prompted the emergency department to temporarily relocate to another part of the hospital. After law enforcement personnel conducted a sweep of the emergency department and determined it was safe, staff and patients were permitted to re-enter the area.[11]

## Exercises

Hospitals conduct exercises to validate and test response plans. These exercises test staff members' expertise in their MCI roles and responsibilities and identify strengths and gaps within response plans. Boston hospitals conducted multiple exercises to rehearse plans for responding to an MCI. The following exercises improved preparedness and resulted in a coordinated response effort after the Boston bombings:

> *"Hospitals are required to do a multitude of exercises within their facilities every year, and that contributes to response when something actually happens."*
>
> Mary Devine, Emergency Management Coordinator, Conference of Boston Teaching Hospitals

- Operation Prometheus was a multi-day exercise in 2002 that simulated the explosion of a dirty bomb on an inbound airliner in Boston. Over 50 agencies and 10 hospitals in Boston participated in the exercise to evaluate all aspects of emergency response.

One primary aspect of the exercise was to test hospital procedures for diagnosing and treating patients who were contaminated or injured. This key exercise activity significantly contributed to the successful response in Boston hospitals' ability to diagnose and treat the large number of patients received after the bombings.

Operation Prometheus consisted of multiple phases designed to test hospitals and their ability to accept and process victims of an MCI. Hospitals activated their command centers as they would during a real emergency. Activating the response procedures allowed command center staff to assess communication and cooperation between all agencies involved with emergency medical response.

Additionally, the exercise familiarized hospital staff with evidence collection activities and the communication of patient information to the proper authorities for identification.[12] Hospital staff at MGH carried out similar efforts after the marathon blasts by providing clothing and recovered shrapnel to the FBI. This helped to identify the type of bombs used in the attack.[13]

- In 2011, hospitals participated in Operation Falcon II, a functional exercise meant to test response plans and the ability to handle a surge of patients. The exercise consisted of a collapsed building scenario that resulted in an explosion and a fire.

  Operation Falcon II evaluated information sharing, critical resource coordination, and medical surge capacities for regional hospitals and community health centers. The exercise identified areas of improvement, but largely demonstrated the effectiveness of response plans during an MCI for Boston hospitals, community health centers, and Emergency Medical Services (EMS) agencies.[14, 15]


**Emergency Department staff during Operation Falcon II (Source: Metro Boston Homeland Security)**

## Hospitals Response

Immediate notification of the bombings alerted hospital staff with enough time to prepare emergency departments before patients arrived. Past exercises that tested communication plans led to improved flow of communication between response agencies and hospitals following the bombings. The Medical Intelligence Center (MIC) notified Boston hospitals minutes after the incident.[16, 17] According to Mary Devine, Emergency Management Coordinator with the Conference of Boston Teaching Hospitals, "within minutes, the trauma centers cleared out their emergency departments [and] opened up the operating rooms."[18] At MGH, where 37 victims were treated, staff cleared the emergency department of as many patients as possible to prepare for the blast victims.[19] Beth Israel Deaconess, BWH, and Tufts Medical Center all activated similar plans.[20, 21] Table 1 lists the number of patients received in each Boston hospital.

The State Emergency Operation Center (SEOC) consistently updated hospitals with information about the incident as it evolved. The information informed staff of the number of patients en route and what injuries to expect. As a result, emergency department staff in

Boston hospitals mobilized equipment for the vascular and orthopedic procedures they expected to conduct. Additionally, hospitals used the statewide WebEOC system to acquire and provide real-time data and updates on equipment and staff availability. The rapid WebEOC updates played a central role in keeping medical providers informed of the types of injuries to expect and the personnel available to provide assistance.[22] The communication between Boston hospitals helped determine whether an emergency department was lacking specific equipment that another hospital could provide.

Hospitals remained in communication with coordination centers to exchange vital information during the aftermath of the incident. Coordination centers provided hospitals with information on incident developments. Conversely, hospitals shared patient identification information with the MIC so that they could locate the families of the patients and reunite them.[23]

| Hospitals | # of Patients Received |
|---|---|
| Beth Israel Deaconess Medical Center | 24 |
| Boston Children's Hospital | 8 |
| Boston Medical Center | 29 |
| Brigham and Women's Hospital | 38 |
| Massachusetts General Hospital | 37 |
| Tufts Medical Center | 28 |

**Table 1: Number of patients that each Level 1 trauma center received after the Boston Marathon Bombings (Source: Mary Devine, Presentation at Conference of Boston Teaching Hospitals.)**

### *Patient Triage and Care*

A major life-saving factor after the incident was the short time span between when the blasts occurred and when victims received medical attention. For victims who sustained severe injuries, receiving rapid medical triage and care immediately after the blasts dramatically increased their chances of survival. EMS at the medical tent had IV bags, blood-pressure monitors, and tourniquets to stabilize victims.[24] Once stabilized, EMS loaded victims into ambulances and transported them to hospital trauma centers. Quickly applying tourniquets in the field and en route to trauma centers played a large role in patient survival. According to Joseph Blansfield, Trauma Program Manager at Boston Medical Center (BMC), the result of applying tourniquets was "bleeding was able to be staunched, and as a result, people arrived in better physiologic states and didn't require as much resuscitation as they otherwise would have." In years past, medical providers often cautioned against the use of tourniquets due to the fear of doing more damage than good. Therefore, ambulances and EMS staff typically didn't carry tourniquets. However, lessons from successfully treating battlefield injuries in Iraq through the quick application of tourniquets have reduced this fear. Similar to providing military members with tourniquets as part of a standard field medical kit, Boston ambulances now carry tourniquets as a standard item in their inventory.[25]

**Medical teams assist the injured during the aftermath of the incident (Source: FEMA.gov)**

Injuries sustained near an IED blast are typically extensive and require a knowledgeable staff well equipped for trauma care. Upon arrival at any of the trauma centers, hospital staff conducted patient assessments to determine the right course of action. The variety of injuries sustained, according to the Department of Emergency Medicine at BWH, included open fractures, amputations, burns, and shrapnel wounds that required complex procedures and careful coordination across surgical disciplines.[26] Similarly, Andrew Ulrich, MD at Boston Medical Center stated that they "saw a lot of extremity injuries, a lot of amputations." Many of these injuries required extensive and multiple surgeries.[27] At BWH, following the patient assessments, the operating-room director handled triage operations and determined what operating rooms to use for each following patient.[28] The regular training and exercises that Boston hospitals conduct ensured that staff was prepared to deliver trauma care for the large number of patients resulting from the bombings.[29]

### Summary of Observations on Hospital Response

In responding to the Boston Marathon bombings, hospitals and healthcare professionals demonstrated the benefits of conducting preparedness efforts. Hospitals in the Boston area were able to activate response plans once alerted, and provide immediate medical care for the surge of victims. The following factors contributed to the successful efforts by hospital staff:

- Hospital command centers remained in constant contact with public agencies and operation centers in Boston. Hospitals that maintained real-time information sharing with EOCs and EMS on site were able to activate emergency response plans immediately. Because hospitals activated plans before patients arrived at the hospital, the amount of delay once patients arrived was minimal. Throughout the aftermath, hospitals used the communication with coordination centers to share key information about their patients, such as identification information.[30]

- Hospital emergency departments relied on response plans and training during the surge of incoming patients. Members of the hospital staff were familiar with their roles and responsibilities because of the training and exercises they had previously conducted. Additionally, hospitals developed plans with first responders, ambulance services, and law enforcement to successfully coordinate a hospital response during an MCI.[31]

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