

# Be Prepared — The Boston Marathon and Mass-Casualty Events

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On April 15, two improvised explosive devices (IEDs) were detonated in short succession near the finish line of the Boston Marathon, in the middle of a densely packed crowd of thousands of runners, families, friends, and spectators. Three people were killed and 264 were injured,<sup>1</sup> with more than 20 sustaining critical injuries. Yet in the face of these tragic and horrifying events, despite catastrophic injuries not commonly seen in civilian medicine and the fact that these were the first IEDs to cause mass injuries in the United States, the overall medical response has generally been considered successful.<sup>2</sup>

Victims at the blast scene received immediate, lifesaving aid. Crucial stabilization of trauma injuries was provided in the medical tent near the marathon finish line. Patients were rapidly triaged and loaded into ambulances. Within 45 minutes, the last of the injured patients was transported from the scene. Each of the city's major trauma centers received approximately equal numbers of critically injured victims. No one who was transported to a hospital died.

The fact that there was not more loss of life is attributable to more than just providence and the extraordinary skill and courage of the volunteer and professional responders. As Kellermann and Peleg note in their Perspective article, the response was enabled by the medical community's prior efforts to build and sustain emergency-preparedness programs and, perhaps

most important, to practice its response in exercises and drills.

For more than a decade, emergency managers in Boston's medical community, like those in other cities, have been refining plans for mass-casualty events. Every year, they review the literature to learn from others who have faced such events. For example, in 2008 and 2009, Boston hosted two symposia, cosponsored by the Centers for Disease Control and Prevention and the Harvard School of Public Health, on planning for and responding to terrorist bombing incidents. Speakers from London, Madrid, Mumbai, and Israel shared their experiences in caring for overwhelming numbers of patients after a mass attack and the lessons they had learned. The speakers described common challenges, such as navigating the chaos that follows an explosion and coordinating the sharing of information among responding agencies and institutions. They commented on difficulties in rapidly triaging patients and distributing the most severely injured appropriately among area hospitals. And they stressed the operational challenges at receiving hospitals that are caused by very limited preparation time.

Boston's emergency managers and medical leaders have used this knowledge when planning for special events such as the marathon. Because of the size and complexity of the Boston Marathon, an event that each year typically produces more than 1000 medical encounters in less

than 6 hours, the Boston Athletic Association annually assembles a medical leadership team of sports, cardiovascular, and emergency medicine specialists and works with area public safety, emergency management, hospital, and other officials to ensure that resources are in place to handle the anticipated medical needs. Medical resources are staged in medical tents along the 26.2-mile course and include physicians, nurses, emergency medical technicians, paramedics, and other professionals.

The medical tents' primary goals have been to provide prompt medical care to those who need it and to avoid overloading area emergency departments (EDs). Providers working in those tents have traditionally treated both minor illnesses and more serious clinical conditions such as myocardial infarction, hyponatremia, and hyperthermia. Seriously ill patients are transported to area hospitals when necessary. Event planners and medical leaders have traditionally used the Boston Marathon as a "planned mass-casualty event" and have taken the opportunity to practice and test the disaster-response protocols and systems of all participating public safety services — police, fire, emergency medical services (EMS), emergency operations, hospital disaster preparedness, and state and federal partners.

When the IEDs went off, Medical Tent A, located beyond the finish line, was rapidly transformed from a site for delivering

medical care for ill runners to a casualty collection point, as Jan- gi describes in his Perspective article, where EMS personnel initiated triage, rapid treatment, and the loading of patients onto ambulances. Bystanders and volunteer medical staff provided lifesaving treatments, including tourniquets to stem severe hemorrhage. One of the important medical lessons from military operations in Iraq and Afghanistan has been that early tourniquet use in those with blast injuries from IEDs dramatically reduces combat deaths from limb exsanguination.<sup>3</sup> Although EMS personnel typically use tourniquets infrequently in civilians, Boston EMS has incorporated tourniquets and associated training into its hemorrhage-control protocol for years; more recently, it has begun preparing for active-shooter mass-casualty incidents by adapting concepts from Tactical Combat Casualty Care.

Immediately after the explosions, Boston EMS also mobilized an extensive network of communications and other resources, calling in available private ambulances to supplement its own. At the Boston EMS Dispatch Operations Center, a physician assisted the loading officer with the distribution of the most critically ill, or “red-tagged,” patients. All ambulance transports were centrally coordinated through that center. The initial 30 red-tagged patients were triaged, treated, and transported within 18 minutes after the explosions.

Boston’s hospitals have also learned from others’ experiences. In this era of overcrowded EDs and full hospitals, how does one rapidly create capacity to receive incoming patients? Other cities’ experiences have taught us that this problem must be addressed.

At the time of the blasts, the city’s hospital operating-room (OR) schedules were booked and most EDs were full. Massachusetts General Hospital (MGH) received five critically injured patients in very rapid succession into a full ED, but after a brief period of evaluation and resuscitation, all five were sent to the OR, within approximately 8 minutes of one another. This was possible only because of preexisting plans that supported rapid transport of many patients who were being evaluated in the ED to inpatient floors, where their evaluation and clinical care were continued by the inpatient hospital teams, and because of plans to rapidly open multiple ORs by holding pending cases and mobilizing OR personnel. In total, MGH received 31 patients in approximately 1 hour, but the hospital could have accommodated even more injured victims if necessary. This response would not have been possible without prior institutional plans that anticipated these needs. Just as effective trauma systems coordinate the response and contribution of myriad clinicians and specialists to effectively care for each patient, the hospitals’ emergency management systems had to effectively manage the response to the medical, emotional, social, and other needs of the victims.

The outcome of the medical response has been partially attributed to an unusually high number of teaching hospitals and trauma centers<sup>4</sup>: Boston has 6 hospitals designated for either adult or pediatric trauma care, and all 10 of its hospitals have some affiliation with one of the three medical schools in the city. As Kellermann and Peleg indicate, other fortuitous facts also played a role — for example, the mara-

thon finish line is centrally located, so the distances to many of the trauma centers were similar.

It’s important to recognize that the response in Boston generally followed a very carefully crafted and much-practiced set of plans and that those plans owe much to the lessons of others in the unfortunate fraternity of cities that have experienced mass casualties from intentional attacks. We believe that the speed and coordination of the response is partially attributable to reviewing other cities’ experiences, adjusting our plans, and repeatedly training staff in implementing those plans. In this context, it seems especially unfortunate that U.S. health departments, hospitals, and EMS are facing severe budget constraints, owing to cuts in federal funding that will undermine planning, training, and practice activities that have been so important in building health emergency preparedness capabilities. Nonetheless, as we review our successes and failures in detail, we will endeavor, in turn, to share our findings with others.

It’s often said that disaster medicine is a team effort. But we must sustain our focus as a nation to examine experiences together, plan together, and train together if we are to truly say that we’re learning the lessons of others and improving our ability to respond.

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

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## We Fight Like We Train

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As we say in the U.S. Navy, “We train like we fight, and we fight like we train.” In Boston, we do the same.

That was never more evident than at 2:50 p.m. on April 15, when two explosive devices abruptly shattered the 117th Boston Marathon. On Patriot’s Day, the day we commemorate the opening battle of the Revolutionary War in Lexington and Concord, Boston was under attack.

Over the past 8 years, Brigham and Women’s Hospital (BWH) has activated the emergency response team on 78 occasions. We have activated it for both real-world events and drills based on a wide array of scenarios — chemical attacks, oil spills, train crashes, blizzards, and building evacuations. Eight times we practiced mass-casualty drills simulating the human fallout from bombings, aircraft accidents, and “active shooters,” such as those at Sandy Hook, Connecticut, and Aurora, Colorado. These drills have been departmental, hospital-wide, citywide, and statewide. They taught us familiarity, comfort, trust, and routines. On April 15, these routines saved lives.

At 8 a.m., in accordance with our annual Patriot’s Day protocol, our emergency management director opened the hospital’s Emergency Operations Center.

At 2:49 p.m., the nurse in

charge of Alpha Pod (one of four separate 14-bed pods, all within the larger emergency department [ED]) conducted a scan of our 55-bed ED. It was full: 47 patients in beds, 6 in the hallway, 6 in the waiting room, and 4 in the triage area.

One floor below the ED, our perioperative nurse administrator reviewed his caseload: 30 of 42 operating rooms (ORs) were active, with 8 more available for the 4 patients waiting in the preoperative area. An additional 15 elective cases remained on the schedule for that busy Monday.

At 2:50 p.m., reports of an explosion came over the Boston Fire and emergency medical services radio frequency.

At 2:54 p.m., the Central Medical Emergency Direction Center hotline rang in Alpha Pod, reporting two explosions and incoming patients. The lead emergency medicine (EM) physician in Alpha Pod, recalling her experiences in Haiti after the 2010 earthquake and as incident commander during a practice drill for responding to mass casualties from a bomb in March 2011, huddled with the nurse in charge of Alpha Pod and the emergency management director. This team quickly assessed the crowded department and prepared to receive victims; their first task was to clear the ED of current patients.

The Boston Public Health Commission’s Medical Information Center called; BWH would be receiving 8 patients from the scene. The team initiated Code Amber, our hospital-wide disaster response.

A senior EM resident who had attended a disaster-management training session in October 2012 reminded the team to consider the possibility of a hazardous-material (HAZMAT) threat.

As reports trickled in — that there was a fire at the John F. Kennedy Library across town, that other devices had been found — the emergency management director recalled the 2008 Mumbai attacks, in which a mass shooting was followed by an attempted assault on the hospital where victims were sent. He directed security to lock down the hospital and open the HAZMAT decontamination unit.

In Alpha Pod, the chief of the Division of Medical Psychiatry coordinated the placement of 8 patients awaiting psychiatric beds by transferring them to our surge pod or to McLean Hospital in Belmont. He spoke with every psychiatric patient, calmed one patient who believed the unfolding events were his own delusion, and collaborated with social workers to identify the psychosocial needs of patients and their families.

Teams of internal medicine