

'This is our day': How Tufts Medical Center does the Boston Marathon

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Abstract Each year on the third Monday in April, athletes, volunteers and spectators alike celebrate the running of the Boston Marathon. With a course that spans eight cities and towns over 26.2 miles, the Marathon is an annual large-scale event that requires state-wide efforts to ensure the health and well-being of all participants. No stranger to

events of this magnitude, Boston also hosts one of the nation's largest New Year's Eve celebrations, is home to a wide variety of St. Patrick's Day events, including the annual South Boston parade, and is renowned for its nationally broadcast Independence Day festivities. This document outlines how Tufts Medical Center (Tufts MC), a 415-bed academic medical facility in the heart of downtown Boston, manages large-scale planned events such as the Boston Marathon from an individual hospital administration perspective. This well-tested but dynamic response strategy to events of this size is a product of robust hospital preparations, streamlined operations and liaising with external agencies. Successful implementation of this plan allows for accommodation of a greater than 40 per cent increase in Emergency Department (ED) daily volume: flexibility utilised not only on Marathon Monday, but also during additional large-scale events in Boston throughout the year.

KEYWORDS: marathon, hospital, planned mass casualty incident, mass casualty event

MARATHON PREPARATION

Tufts MC Boston Marathon planning begins the second week of March each year. The event is approached as a 'planned' Mass Casualty Incident (MCI), in a similar vein to hospital planning for New Year's Eve, St. Patrick's Day and Independence Day celebrations in Boston. For events of this magnitude, Tufts MC applies standardised Hospital Incident Command System (HICS) protocols. Incident management is divided into Planning, Operations, Logistics and Finance categories. Tufts MC has also customised their HICS by adding a Research section; however, it has not historically been activated for the Boston Marathon.¹

Each scheduled MCI follows a pre-defined Incident Action Plan, the model for which has been in use since 2010 at Tufts MC for Marathon operations, and is subject to annual review and augmentation. The plan first focuses on staffing: a subsection of ED Operations. Under the direction of department leadership, the number of personnel within the ED is scaled up to accommodate an anticipated increase in patient volume for the day (Table 1). Utilising this comprehensive staffing infrastructure ensures sufficient care teams are in place to treat an increased patient volume, and promotes overall staff

and patient safety during peak treatment hours.

In addition to these regular staffing increases, there are also a patient sitter, a respiratory therapist and a pharmacist dedicated to and present in the ED, and a laboratory supervisor dedicated to ED Operations in the central hospital laboratory.

Planning

Once ED operational directives are outlined for Marathon Monday and the days immediately surrounding the event, ED Leadership in conjunction with hospital emergency management begins to widen the scope of involved parties. This includes the development of a comprehensive, Boston Marathon-specific Operations Plan. Components of the plan include race information, race day operations information, Tufts MC HICS activation personnel identification, an event timeline, communications and media interest information, personnel responsibilities, a support operations checklist, guidelines for patient tracking and sharing of information during the event, scheduled road closures, internal floor plans, maps and ED protocols.

Table 1: Emergency department staffing increase for planned MCI

Staff	Increase
Attending MDs	From 5 to 6 <i>Swing attending hours modified such that they will stay an additional 2 hours before or after scheduled shift</i>
Physician Assistants	From 1 to 2
RNs	From 9 to 13 <i>Staffing increase specific to peak hours of 13:00–21:00</i>
Clinical Care Technicians	From 5 to 10
Social Workers	From 1 to 2
Registration Personnel	From 3 to 4 <i>Dedicated to the ED 11:00–23:00</i>
Transporters	From 1 to 3 <i>Dedicated to the ED 11:00–23:00</i>
Housekeeping Staff	From 1 to 2 <i>Dedicated to the ED 11:00–23:00</i>

Table 2: Common marathon-associated diagnoses

Hypothermia
Exercise associated syncope
Exercise associated hypohydration
Hyponatremia
Heat cramps
Heat exhaustion
Heat stroke
Exertional rhabdomyolysis
Hypernatremia
Dehydration
ST elevation Myocardial Infarction (STEMI)/increased troponin levels

Planning in advance of the Marathon further includes elements with direct impact on patient care. Runners are not required to disclose past medical history, allergies or medications in advance of participation; however, they are encouraged to write pertinent information on the back of their race bib in the event they become incapacitated over the course of the event. Once a patient is received at Tufts MC, clinicians utilise event-specific medical protocols for commonly encountered diagnoses (Table 2), as well as event-specific

laboratory orders as indicated (Table 3) to ensure quality, rapid care for Marathon participants.

All specimens and transport bags are labeled 'Marathon Runner' to ensure 15-minute turnaround time from the hospital laboratory.

Planning meetings continue throughout March and April, with 'Boston Marathon' as a standing agenda item on pertinent internal hospital committee meetings, as well as external committee meetings in which Tufts MC Emergency Management represents the hospital.

Table 3: Event-specific laboratory orders

Event-specific laboratory orders	Indication	Additional information
Rapid sodium with or without additional electrolytes	Rule out electrolyte abnormalities with cardiac or neurologic impact	Collected in lithium heparin tube for analysis
Cardiac enzymes	Rule out cardiac injury	–
Urine specific gravity	Assessment of hydration status	Patients must void prior to discharge
Urine ketones	Assessment of nutrition	Patients must void prior to discharge
Urine blood	Assessment for potential rhabdomyolysis	Patients must void prior to discharge

Operations

Recognising that collaboration is the key to successful operations, approximately two weeks before the Marathon, Tufts MC ED Leadership hosts hospital administration, departmental leadership, the Chief of Boston Emergency Medical Services (EMS) and the Medical Coordinator of the Boston Athletic Association (BAA) for an annual pre-planning breakfast. This marks the ‘unofficial kick-off’ for Boston Marathon operations. Individualised planning sessions then take place across departments throughout the hospital to ensure communication and cooperation across disciplines. Departments involved include but are not limited to: Administration, Center for Patient Placement, Central Staffing Office, Admitting, Intensive Care Units, Medical-Surgical Units, Emergency Medicine, Surgery, Ambulatory Medicine, the Cardiac Catheterization Laboratory, Pharmacy, Respiratory Therapy, Radiology, Laboratory, Social Work, Case Management, Transport, Environmental Services, Public Safety, Environmental Health and Safety, Medical Engineering, Patient Care Equipment, Receiving/Supply Chain and Dietary Services. This multidisciplinary approach stresses that the Boston Marathon is not just an ‘Emergency Department’ event, but an ‘Enterprise-Wide’ endeavour. Departments from throughout the hospital have specific roles and protocols that are used prior to, during and in the recovery phase following Marathon Monday, particularly the

Medical-Surgical and Intensive Care Units, to which higher acuity patients are dispositioned following entry through the ED.

One of the central objectives for management of operations on Marathon Monday is patient flow, specifically patient admissions, discharges and transfers. This is the main function of the Tufts MC Center for Patient Placement (CPP): a hub from which staffing, bed flow, transport, housekeeping, internal EMS transfers, and overall case management is performed. The CPP becomes one of the most critical players throughout all phases of Tufts MC’s Boston Marathon events. Five days prior to Marathon Monday, hospital administration begins to closely monitor patient census. As the event gets closer, Case Management is empowered to remove any impedance to discharging patients from the facility in preparation for a major influx through the ED. Conference calls and an increase in e-mail communication take place throughout the weekend prior into Sunday evening, and on Marathon Monday, teaching rounds and other non-essential education are cancelled so that the focus is strictly on patient care and appropriate and timely discharges. This concept is referred to as ‘surge/purge operations’. In addition, Marathon Monday is held on Patriot’s Day each year. While not a state or federal holiday, this is a county holiday during which both operating room and clinic schedules tend to be lighter than usual. Ambulatory clinics are

Table 4: Tufts MC departmental responsibilities for planned MCIs

Hospital department	Planned MCI function
Emergency Management	Coordinating overall planning and response for events including conveyance of pertinent information from the city to ED and escalation of the incident if needed. Emergency Management will also obtain any necessary supplies and materials from vendors or state/federal entities.
Transport	Stocking of stretchers and wheelchairs in the ED at all times during the event, and staging additional transport in a pre-defined location. Dedicated transporters will be on staff for ED needs during peak hours of event.
Public Safety	Maintaining perimeter security for the ED including visitor access. Team members will coordinate frequent communication with Emergency Management and other response personnel as needed, and will also be responsible for Ambulance Bay traffic control.
Facilities	Providing additional environmental or utility support as needed during the event.
Environmental Services	Coordinating room turnover and overall department cleanliness. An additional housekeeper will be assigned to the ED during the event to assist with room turnover and clean-up.
Patient Care Equipment (PCE)	Pre-stocking of IV pumps, transport monitors, oxygen tanks, IV poles, pulse oximeters, linen, etc. All equipment is also available through a PCE Pool that is accessed through a pre-defined pager. A PCE Technician is in-house throughout the event and is placed on alert to make the ED a priority.
Media Relations	Addressing all media inquiries as directed to a pre-defined Media Relations pager. Typical inquiries may include patient counts and conditions, which Media Relations may proactively provide to ED personnel.
Registration	Providing additional registration support as needed to accommodate patient influx throughout the event.
Social Services	Ensuring donations, cab vouchers, and warm clothes are available to patients. Will also assist in finding transport and/or placement of displaced patients associated with the event.
Laboratory	Prioritising STAT ED labs during event. Will also provide custom labels placed with patient samples during events to identify participants.
Information Technology	Establishing marathon-specific protocols within pre-existing medical software programs. Will also provide support for hospital-wide patient tracking throughout the event.

encouraged to defer sending patients to the ED unless absolutely necessary, while hospital operations increases efforts to accommodate impending outside hospital transfers as direct admissions.

Additional departmental breakdown of responsibilities at Tufts MC for Boston Marathon operations are as follows (Table 4).

Associated operational changes are announced to the hospital community four days before the Marathon, including activation of a command centre pager, casualty care tent deployment, public safety control of local parking meters, valet service changes to accommodate EMS traffic, direction of unnecessary foot traffic away

from the ED, local road closures and public transport information.

Logistics

To support the operational objectives of all stake-holding departments, the following standard equipment and resources checklist has been developed for deployment to the ED in preparation for patient influx (Table 5).

Finance

All race preparation equipment and logistical costs are tracked by Emergency Management. Costs for staffing increase are tracked by individual departments.

Table 5: Emergency department support operations checklist

Surplus electrocardiogram (ECG) monitors
Sodium broth
Pre-assembled laboratory blood draw bags and laboratory slips
IV pumps (20)
Pulse oximetry monitors (4 in express care area plus 8 mobile)
Oxygen tanks (cart)
Portable vital sign monitors (3 in the department, up to 5)
Cardiac chairs for casualty care tent (5)
Additional IV poles (5)
Additional linen cart
Pre-bagged IV set-up kits with cart for transport
IV bags (100 NaCl plus 20 Lactated Ringers — Hypertonic (3% NaCl) solution available via Pharmacy)
Stretchers and wheelchairs
Ice immersion tub for hyperthermic patients
Box fans (5)
Cooling bottles (24)
Cases of Gatorade (50)/cases of water (100)
Refreshments/food for staff as well as EMS

EXTERNAL LIAISONS

The hospital receives pertinent race day information and intelligence via the Conference of Boston Teaching Hospitals (COBTH): an umbrella organisation designed to bring Boston academic medical centres together for collaborative purposes. The BAA provides local hospitals with a comprehensive medical manual, Marathon fact sheet, Marathon flow chart and instructional videos on treatment protocol best practices. The Boston Regional Intelligence Center Boston Marathon Joint Assessment Intelligence Report, an overview of potential threats and hazards compiled by local and federal public safety agencies, is also shared with hospital leaders prior to the race. In addition, a statewide Course Disruption Plan is established and activated on an as-needed basis, with Tufts MC capable of initiating a Code Grey Plan (lockdown) from its own Command Center, if appropriate.

The Boston Medical Intelligence Center (MIC), a multiagency coordinating centre

for public health and health care agencies for the city of Boston, provides the hospital with situational briefings pre-, during and post-event, and functions as a hospital logistical resource throughout the day. Regular communication from the MIC allows for capacity awareness through use of an established patient tracking system as coordinated by the Massachusetts Department of Public Health (DPH). Anyone seeking medical assistance who is associated with the Marathon, regardless of runner, volunteer or spectator status, is followed using the web-based patient tracking system, EMTrack, through the duration of their care. EMTrack provides patient demographics, triage status as assessed by a clinician, and disposition information, with runner demographics pre-populated into the system from information provided in advance of the race. The information available through EMTrack further aids in family reunification efforts at the conclusion of the event. As the Marathon attracts

Table 6: Marathon Monday Event Timeline

00:00–06:00 Final preparation of supplies and cleaning of the ED
06:45 Incident Commander and resources unit leader meet to begin resource deployment
07:00 Resource deployment to ED begins
08:00 Incident Command Post established in ED
08:30 Casualty care tent set-up begins
08:45 Patient flow status update
09:30 Hospital Command Center established
10:00 Command staff briefing #1
11:30 ED safety briefing #1
12:00 Patient flow status update
12:45 Valet shifts to accommodate increased EMS traffic
13:00 Command staff briefing #2/Massachusetts Department of Public Health conference call #1
13:30 ED safety briefing #2
14:00 Emergency Management situation report #1 sent
14:00 Incident Commander and resource unit leader status check
14:30 Patient flow status update
16:00 Command staff briefing #3/Massachusetts Department of Public Health conference call #2
17:00 Emergency Management situation report #2 sent
17:30 Patient flow status update
18:30 Final command staff briefing (if needed)
19:00 Hospital Command Center demobilised
19:30 Final ED safety briefing
20:30 Final Emergency Management situation report sent
21:00 Casualty Care Tent demobilisation
22:00 Incident Command Post demobilisation and ALL CLEAR

participants from throughout the world, communication with non-English speakers is made possible through use of smartphones with translation applications as provided by the BAA, as well as utilisation of a translation company available by phone for access to an additional 27 languages.

DAY OF THE MARATHON

Evidence-based practice from previous years dictates that maintaining frequent communication and regular ‘check-ins’ with all departments throughout the hospital provides positive outcomes in both patient care and ED throughput. The event timeline

presented in Table 6 has been used with minor adjustments in five of the last six years (2011 through 2016, 2013 excluded) as a format to manage operations. Command staff and safety briefings coincide with state and city briefings, as well as the overall timeline of the race (Table 6).

As the event proceeds, continued communication with external liaisons allows for situational awareness regarding patient volume and course conditions. One of the most influential variables on Marathon Monday patient volume is race-day weather: an element that can vary even over the length of the race course. With a runner field size of greater than 30,000 annually,

‘race organisers plan for a 3–5% casualty rate if the weather is approximately 68°F or less. Once the temperature begins to get in the range of 70°F or higher, this number can quickly jump to a 10% casualty rate.’² A casualty is defined as any athlete, volunteer or spectator needing any type of medical treatment, which may or may not result in transport to the hospital. Historically, Tufts MC sees a direct relationship between maximum temperature in Boston as reported by the National Weather Service and daily ED census on Marathon Monday (Figure 1).

On Marathon Monday, there are four predictable ‘waves’ of patients that present to the ED. The first wave begins at approximately 13:30, while heaviest patient flow occurs in waves two and three, between 15:00 and 17:00. As the closest hospital to the Marathon finish line, Tufts MC will see a unique additional fourth wave of runners: individuals who complete the race, return to their hotels close to the

finish line and start to feel ill, presenting to the ED into the late evening. Historically, Tufts MC will treat at least 25 additional patients over and above standard ED volume on Marathon Monday. Challenges are attributed to a high number of low- to mid-acuity patients and a low number of high-acuity admissions, all presenting within a period of a few hours.

POST-MARATHON ANALYSIS, 2016

In 2016, the Boston Marathon saw 30,741 registered runners with an anticipated 8 per cent attrition rate, ultimately resulting in 27,488 participating,³ plus possible unregistered ‘bandit’ runners who join the race on the day of the event. With weather forecasts in advance of the Marathon ranging from 66°F to 72°F, Tufts MC braced for high numbers of casualties and ramped up an expansion plan for alternate care sites on campus. These included ED hallways, waiting areas, a casualty care tent, the Hospital

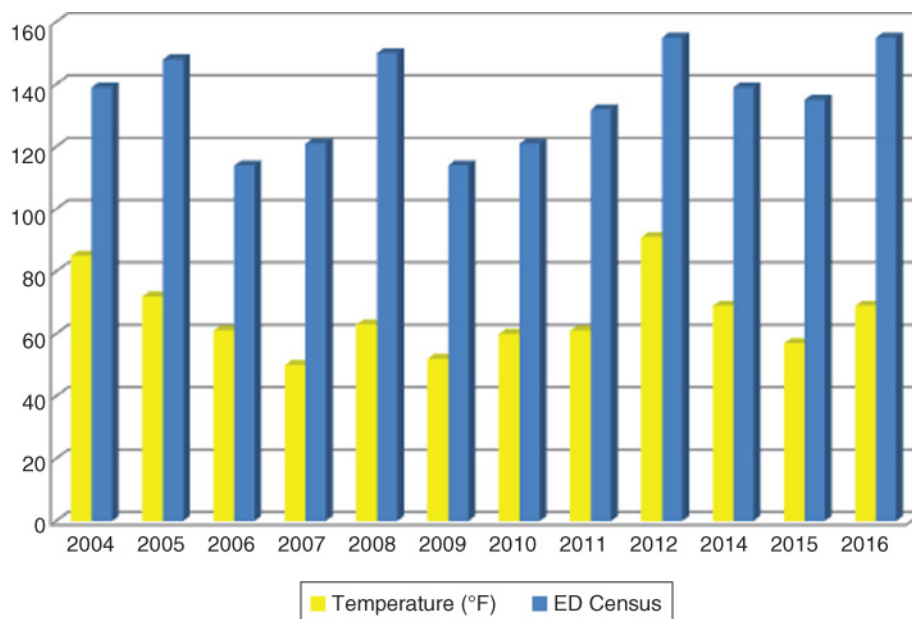


Figure 1: Maximum reported temperature in Boston and Tufts MC Emergency Department census on Marathon Monday, 2004–2016. 2013 omitted

Atrium Dining Pavilion, and an ambulatory care building. Preparation to move towards these alternate care sites included logistical elements such as IV fluids and set-ups, computer workstations on wheels, commodes, additional ECG acquisition equipment, code carts, linen and food provisions, as well as staffing, including but not limited to nurses, clinical care technicians and security personnel.

As anticipated, the weather posed the greatest challenge in Tufts MC's response to the 2016 Boston Marathon. At the beginning of the course, conditions were sunny and temperatures hovered around 69°F, causing several runners to drop out of the race within the first few miles and well in advance of arriving in Boston. This warmer inland temperature placed a strain on course medical tent operations earlier in the day, and it was found that patients who did seek hospital-level care did so later than anticipated on race day, possibly due to longer individual race times.

Following the 2016 Boston Marathon, after-action items were identified to modify best practices and improve future responses to large-scale planned MCIs. In addition, Tufts MC adopts a philosophy that, just as imperative as fixing after-action items is ensuring continuation of elements that went smoothly. The areas identified following the 2016 Boston Marathon were primarily communication- and operations-based.

Communication

Communication from course medical tents, COBTH and the MIC occurred throughout the day at pre-scheduled intervals. Of note, the DPH hosted three hospital-specific conference calls to ensure response levels and capabilities were unified across the city. A major focus both internally and externally was bed capacity. All hospitals in and out of the city are required by DPH to communicate in real time at pre-scheduled

intervals the number of hospital beds available. In 2016, the level of pre-planning around current trends of high census began midweek, the week prior to the Marathon, while capacity/command huddles took place throughout the day and evening before. On analysis after the Marathon, these meetings and frequent communication were determined to be an effective approach, as the ED was able to accommodate 50 patients at one point in the evening, and as such management of future planned MCIs should emulate frequent communication and pre-planning as appropriate to meet the needs associated with high patient census. In addition, the 2016 Marathon required an emergency bed huddle at 22:00 the night prior to the event despite a large number of beds made available through purge efforts. Extra staff were placed on patient floors to successfully accommodate volume, and it is recommended to call on additional staff as appropriate to meet the needs of the patient census.

Within the ED itself, continuous internal communication between the ED charge nurse, attending physicians and the Director of the Center for Patient Placement successfully facilitated situational awareness throughout the day. Following the Marathon, an after-event e-mail regarding Marathon response activity was sent to the hospital and departmental leadership within 24 hours; however, it is feasible and recommended to provide more frequent communication summaries during and prior to 24 hours after the event to promote situational awareness.

Operations

Formal debriefings on operational needs took place internally and externally within one business week of the Marathon to discuss logistical concerns and resource utilisation. Across the city, there were greater than 2,800 medical encounters, of which

Tufts MC received 28 patients: 23 runners, 1 volunteer and 4 spectators. Of those treated, eight runners were admitted for continued medical care, with one to the intensive care unit following a recorded body temperature of greater than 108°F in a course medical tent. One runner admitted left against medical advice.

The staffing ratios proposed during pre-planning, based on previous years' needs, was shown to effectively manage the anticipated patient volume of the day. ED leadership highlighted the importance of 'crowd control' among employees who desire to help, allowing those assigned to specific duties ample room and resources to work without distraction. Of note, Tufts MC typically anticipates seeing a surge of patients around 13:30; however, 2016 presented high course temperatures resulting in longer individual race times, pushing the surge to around 17:00, when staffing was scheduled to ramp down for the evening. By 18:00 the ED was at capacity due to both EMS traffic and occasional walk-in patients, and many staff stayed later than originally anticipated to handle patient flow. Following this, it is recommended to modify staff schedules as appropriate to meet the day's needs, and to inform staff in advance of the event of the variability of anticipated patient volume due to weather.

Although anticipated, there were no major equipment challenges throughout the day. Although a casualty care tent was staged in the ambulance bay in anticipation of high patient volume, weather conditions were such that it was no longer practical to treat patients in the cold and shade outdoors at the time when more space was needed. From 18:00 to 21:00 the hospital's Atrium Dining Pavilion was converted into a patient care area for five individuals, one of whom would later be admitted. The use of this alternative care area was successful, allowing the ED to flex up to 10 beds, thanks in part to the Environmental Services and Transport teams for providing logistical support.

This resulted in creation of a formalised Atrium Dining Pavilion Expansion Plan for increased capacity usage during future planned MCIs.

CONCLUSION

Although planning and response to large-scale events at Tufts MC is modelled after standard protocols from years past, each planned MCI such as the Boston Marathon has its own incident-specific nuances that require the organisation to be nimble, scalable and adaptive for the duration to allow for successful management. As predicted, the 2016 Boston Marathon presented Tufts MC with a high volume of low-acuity patients, with the few, higher acuity patients associated with complications resulting from a maximum course temperature of 69°F. There were no unexpected challenges throughout the day, and success of the event was attributable to pre-planning at all levels of the organisation, streamlined operations, support from external liaisons and cultural pride for Marathon Monday among the Tufts MC staff. With each running of the Boston Marathon, ongoing evaluation and improvement on emergency management best practices will ensure continued ability to meet patient needs, regardless of what the weather may bring.

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