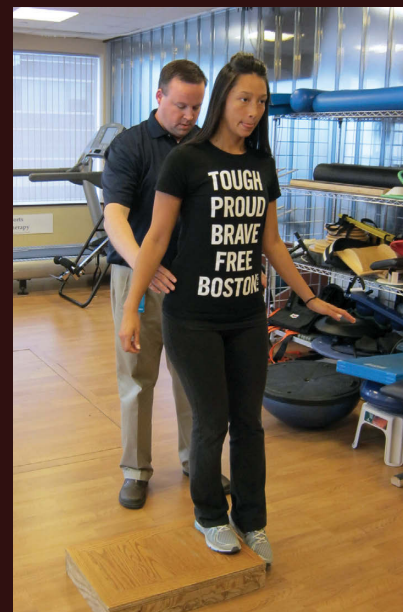




JOSPT

A Special Report From the Publishers of *The Journal of Bone & Joint Surgery*
and the *Journal of Orthopaedic & Sports Physical Therapy*

MARCH 2014



It Takes a Team

**The 2013 Boston Marathon: Preparing for
and Recovering From a Mass-Casualty Event**



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†Gentile, et al. J Pediatr Orthop 2013;33:254-61 Evaniew, et al. Orthopedics. 2013;36(2):e216-e222 Fillingham, et al. Clin Orthop Relat Res 2012;470(7):2014-20
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To name everyone who facilitated the remarkable response to the Boston Marathon bombings would be impossible. For each of the people listed below, who contributed so much to that successful effort, there are dozens of individuals whose heroism and compassion stood out. But those mentioned here, in addition to their daily dedication to preparedness, response, and recovery, devoted extensive time and energy to this special report. For that, an additional and special “thank you” goes out to them.

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- Roseann Sdoia, Marathon patient
- Chris Troyanos, ATC, Boston Marathon Medical Coordinator, Boston Athletic Association
- Ron Walls, MD, Chair, Department of Emergency Medicine, Brigham and Women’s Hospital

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It Takes a Team—The 2013 Boston Marathon: Preparing for and Recovering From a Mass-Casualty Event

March 2014

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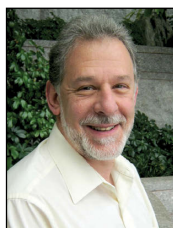
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Cover photo (top middle) credit: *Boston Globe*/Getty Images.

About the Author



This Special Report was written by Lloyd Resnick, developmental editor at *The Journal of Bone & Joint Surgery*. Previously, Lloyd was editor of the *Harvard Heart Letter*, and before that, he worked at the Massachusetts Medical Society as executive editor of *HealthNews* and editor of *Vital Signs*. Lloyd was also the managing editor of a monthly newsletter from the Cummings School of Veterinary Medicine at Tufts University.

Introduction: A Marathon With No Finish Line

At 2:49 PM on April 15, 2013, 2 pressure-cooker bombs exploded near the finish line of the Boston Marathon, killing 3 people and injuring more than 250. Almost immediately, heroic medical interventions occurred, as spectators and trained medical professionals responded to help those in need. In the days that followed, it became clear that endurance would also be needed during extended journeys of recovery, courage, and resiliency.

This special report from *JBJS* and *JOSPT* is about 2 metaphorical marathons—the long and painstaking process of disaster preparedness, and the arduous lifelong recovery faced by those injured in the bombings.

Immediately after the bombs went off, many instinctively ran for their lives. However, first responders, using mental and muscle memory from years of training, joined volunteers, bystanders, and racers who acted on a different instinct. They ran toward the smoke to place tourniquets on the bleeding limbs of strangers and move them away from the chaos. The baton was then passed to emergency medical service triage and loading personnel, who moved injured people into ambulances or staging areas to await transport.

Emergency physicians, trauma surgeons, and nurses—core members of hospital trauma teams—took over next. They quickly resuscitated the patients, identified and stabilized life- and limb-threatening injuries, and transitioned patients to operating rooms for surgery. The pace slowed in the ORs, where surgeons performed their precise and deliberate work on the now-stabilized patients.

Not a single bombing victim who reached a hospital alive that day died, a stunning result of years of preparation and teamwork. But the lives that were given back to the survivors had changed forever. For them, a marathon of another kind was just beginning.

There is no finish line for the Marathon patients—or for the preparedness professionals who helped make the remarkable response that day possible. Patients, and many others in the community less physically affected, will be confronting the aftermath of April 15, 2013 for the rest of their days. Similarly, those who devote their professional lives to disaster preparedness will never be able to say,

“We’re ready for anything.” There is only the interminable task of identifying the gaps in readiness from the most recent horror to help prepare for the next one.

It Takes Teams

News media covering natural and human-induced disasters often observe how communities come together in the face of tragic circumstances. But you can find teamwork everywhere, every day.

After the Boston bombings, every Marathon patient was met and treated at the hospital by a multidisciplinary team of clinicians. Later, other teams of clinicians ensured their physical and emotional recovery and rehabilitation.

And way behind the scenes, in countless meeting rooms and conference calls, during decades of planning and simulated exercises, were more teams, who work day in and day out to prepare for and respond to disasters.

Our report is divided into 3 parts. The first part describes the years of disaster-preparedness activities, tools, and teamwork that led to the effective response on April 15. Part 2 explains how diverse populations of care providers—and several survivors—responded to the emotional and physical injuries in the days, weeks, and months after the bombings. Part 3 reviews lessons learned from the 2013 Marathon and looks ahead to the future for patients and the preparedness community.

The people who died and were maimed by the Marathon bombings stand at the center of this special report. To either side stand teams of people from diverse disciplines, planning and preparing for what might happen next—and helping those affected face the future with hope, dignity, and as much pain-free mobility as possible.

This special report focuses on a place in the world that is fortunate to have an extremely high concentration of health care and emergency-preparedness resources. Nonetheless, we hope that readers living and working elsewhere will identify the translatable principles and practices—and “run with them.”

Kent R. Anderson, CEO/Publisher, *JBJS*

Edith Holmes, Executive Director/Publisher, *JOSPT*

Part 1: Readiness

Fortune Favors Prepared Teams

Chapter 1

Planning for Mass Marathon Casualties

The medical coordinator for the Boston Athletic Association (BAA), Chris Troyanos, ATC, has a main goal for every Boston Marathon—to minimize the impact of the race on the local health care systems, especially hospital emergency departments (EDs). The larger the field of runners and the higher the temperatures on race day, the greater that challenge.

In fact, hot weather had a lot to do with the remarkably effective response to the 2013 Marathon bombings—but not the weather on that particular day, which was nearly optimal for running. It was the unusually high temperatures during the Boston Marathons of 2004 and 2012.

Troyanos refers to those 2 Marathons as occurring on “rogue heat days.” Approximately 2300 people were treated in some capacity in 2004, most for heat-related conditions such as hyperthermia and hyponatremia; 260 of those were transported to area hospitals, and there were no fatalities. “As we looked back on that day, we saw areas in which we could improve our preparedness,” reflected Troyanos.

After meeting with public health and safety officials during a postevent review of the 2004 Marathon at the Massachusetts Emergency Management Agency (MEMA), Troyanos realized that the coordination of systems, relationships, and protocols needed to be enhanced. Since then, all Marathon stakeholders have prepared for the race as a “planned mass-casualty event.” Each Marathon provides the opportunity to use and test systems that can be employed when unanticipated trouble or natural disaster strikes.

Because the Marathon is considered a planned mass-casualty event, all the hospital stakeholders, including all 6 level 1 trauma centers in Boston, have their emergency systems activated on race day.

Every year since 2004, Troyanos has worked with the state health department to convene a multidisciplinary team from the 10 hospitals along and near the Marathon route to ramp up planning and preparedness. He organizes and participates in additional planning meetings with health and medical leaders of local, state, and federal agencies. Each year, stakeholders discuss adjustments based on the prior year’s experience.

Months and years of such multidisciplinary/multi-agency collaboration paid off again during another unusually hot Marathon Monday in 2012, when temperatures hit the 80s. Multistakeholder planning for the 2012 race began the prior December, earlier than usual, because long-range forecasts were calling for an unsea-



Pierre d’Hemecourt, MD (left), co-medical director of the Boston Marathon, confers with Chris Troyanos (right), medical coordinator for the Boston Athletic Association, during the 2012 Boston Marathon.

Expecting the Unexpected

On Monday morning, April 15, 2013, at 8:00 AM, most of the 1400 people who were volunteering as part of the Boston Marathon medical preparedness and response program were crowded into an auditorium for an orientation from Boston Athletic Association medical coordinator Chris Troyanos.

“Who’s here for the first time today?” he asked. He encouraged the one third of the audience who raised their hands to stand up and look at the people who remained seated—the veteran volunteers. “Those people are heroes,” he said. “They saved lives last year. They are the people you should look to for help if you need it.”

Knowing that a weather forecast for perfect running conditions that day might cause a letdown in his volunteers’ readiness mindset, Troyanos left them with this message: “Expect the unexpected. Be prepared for anything.”

sonably warm April. Troyanos and his preparedness colleagues wanted to leave as little as possible to chance. About 275 people were transported to hospitals, some with core body temperatures as high as 108°F. “We saved a lot of lives that day,” said Troyanos. “And it helped us prepare for the unexpected and unimaginable event that occurred in 2013.”

Boston Emergency Medical Services (EMS) chief James Hooley also cited the 2012 Marathon as an example of preparedness success. Boston EMS alone transported 94 people to hospitals with heat-related injuries, and an estimated 10% of the entire running field was seen by at least 1 clinician. Eight hundred patients came through the main medical tent at the finish line. “The physicians in that tent enabled us to treat and release many of those people,” Hooley said, which cut down on the number of hospital transports and potentially overcrowded EDs. Ample physician staffing in the finish-line medical tent was identified as a need in previous post-Marathon preparedness analyses.

Individual Hospital Planning

Troyanos shares the BAA’s overall Marathon-preparedness plan with the 10 stakeholder hospitals, and they integrate the plan into their own emergency-preparedness systems. The route of the Boston Marathon goes right past Newton-Wellesley Hospital (NWH), a 314-bed community hospital with 3400 employees. Charlotte Roy, the hospital’s



Charlotte Roy (left), emergency management coordinator at Newton-Wellesley Hospital, and Denise Shanning, RN (right), assistant nurse manager in the hospital’s ED, check the core temperature of a patient immersed in an ice bath.

emergency management coordinator, is a veteran of planning for marathons, although nothing could have fully prepared her for the events of April 15, 2013, or for the unprecedented manhunt and shelter-in-place order that came 4 days later.

As part of the hospital’s overall preparation, every department at NWH—from facilities and transport to the ED, radiology, and lab—has its own unique Marathon Planning Checklist (see sample in Appendix). In addition to arranging for extra staff on Marathon Monday, Roy and her team plan the event down to the smallest detail, including taxi vouchers for patients who might need them.

Because Marathon day coincides with the Patriots’ Day holiday in Massachusetts, the number of scheduled surgeries is low at NWH, and the hospital turns its gastrointestinal suite into a minor-treatment area to prevent ED overloading. The hospital makes sure its multilingual transport worker is on duty that day, because of the high percentage of runners from foreign countries.

In 2012, the BAA, the hospitals, and everyone in the preparedness community were prepared for multiple heat-related casualties. Roy cleared the top level of the employee parking garage, which is adjacent to the ED, so extra ambulances could be staged there. “We’ve done that a couple of times since then, whenever we might get an influx of more ambulances than we can park in the ED parking area,” said Roy.

Like all other stakeholder hospitals, Beth Israel Deaconess Medical Center (BIDMC) in Boston works with the BAA every year to develop a multidisciplinary team and plan for the Marathon. “We take the BAA manual for the Marathon and develop our own manual from that,” said Meg Femino, the hospital’s director of emergency management. “We talk about the potential for weather-related injuries and any proposed changes to treatment protocols.”

The hospital’s plan includes involvement from just about every department, from the pharmacy to environmental services, from admissions to social work. On

Marathon day, the hospital’s hazmat tent, a preplumbed portable unit that goes up in about 2 minutes, is ready for deployment, and emergency management personnel are on site.

During the 2012 Marathon, BIDMC treated 51 runners and was prepared with ice-bath stations already set up in the decontamination area. The ice-immersion protocol, promulgated by the BAA’s medical directors, was agreed upon in advance in consultation with the BAA and the BIDMC ED director.

Another part of the BIDMC Marathon plan is replacing most of the stretchers in the ED with cardiac chairs. “Fatigued runners don’t usually need to lie down,” explained Femino. “They need to get off their feet, rehydrate, and eat some salty snacks.”

Rob Osgood, emergency management director at Tufts Medical Center, summarized the whole-hospital approach to Marathon planning for all stakeholder hospitals when he said, “The Boston Marathon is not an emergency department event; it’s a Tufts Medical Center event.”

“As you encounter a new risk or incident one year, you prepare specifically for it the next year.”

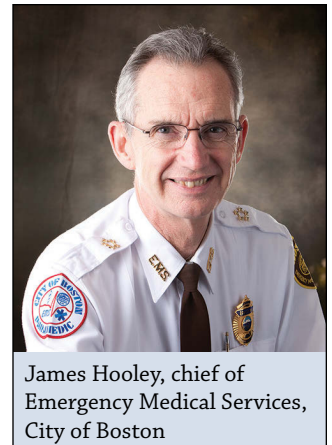
Multijurisdictional Coordination

The Boston Marathon goes through 8 cities and 3 counties, and because Massachusetts is a home-rule state, each jurisdiction has its own regulatory and public health systems. MEMA is the principal planning entity for coordinating the multijurisdictional aspects of preparedness for the race.

Multijurisdictional interaction takes place with 3 pre-Marathon meetings, where local, regional, state, and federal partners of multiple disciplines—including EMS, police, fire, public health, the National Guard, FBI, FAA, and the Bureau of Alcohol, Tobacco, Firearms and Explosives—come together to

discuss possible Marathon-related emergency scenarios.

EMS chief Hooley has participated in many pre-Marathon meetings at MEMA, and in a dozen or so after-action analyses that take place after each Boston Marathon. “As you encounter a new risk or incident one year, you prepare specifically for it the next year,” he explained. Before the bombs went off at the 2013 Marathon, Boston EMS had transported only 8 people to hospitals. But because of what was learned in 2012 and every previous year for the past 30, “when the bombs went off, it wasn’t very difficult for us to shift from a typical Marathon day to a mass-casualty situation with severe trauma,” said Hooley.



James Hooley, chief of
Emergency Medical Services,
City of Boston

Chapter 2

Exercises, Drills, and Training

The key to learning any new skill or behavior is practice. Few people appreciate this more than those in the emergency-preparedness community.

Innumerable preparedness exercises take place in hospitals across the country each year, and more complex exercises involve multiple hospitals and local, state, and sometimes federal disaster-response agencies.

“There is no single perfect exercise,” said Paul Biddinger, MD, chief of the Division of Emergency Preparedness at Massachusetts General Hospital (MGH). “They are all important because that’s

“Frequency of exercises is the most important thing. Highly exercised incident-management teams become almost Pavlovian in their response.”

how the players and stakeholders get to know one another’s capabilities.”

Biddinger thinks 2 specific types of exercises at his hospital contributed to the effective Marathon bombing response: functional hazmat exercises that take place a few times a year, and full-scale federally sponsored Urban Shield exercises that typically involve about 600 people and 50 agencies.

“The hazmat exercises can be either hospital based

or include other entities such as the fire department and EMS,” Biddinger explained. “They usually include patients with both trauma and hazmat contamination and enable us to practice triage, security, and clearing out the ED.” The Urban Shield exercises, as well as Logan International Airport and other citywide exercises over the years, have the whole city of Boston working together. “It helps us to know what EMS, public health, and other hospitals are planning to do and capable of doing,” he said.



Paul Biddinger, MD, chief,
Division of Emergency
Preparedness, Massachusetts
General Hospital

Surge Exercises and Patient Distribution

Clearing out the ED to make room for an incoming bolus of patients is an important early step in almost every disaster situation. The Massachusetts Department of Public

Health (DPH), Boston EMS, the Boston Public Health Commission (BPHC), and the hospitals have participated in medical-surge exercises over the years, so

“All the players have a good idea of one another’s plans,” said Mary Clark, DPH director of preparedness and emergency management. Surge drills show hospitals how to move existing patients out of the ED while continuing to treat them, how to reschedule elective surgeries, and how to open up operating rooms (ORs) for incoming casualties. “The hospitals did a really good job with this on Marathon Monday in 2013,” said Clark.

In collaboration with the Harvard School of Public Health, the DPH provides education and training for Massachusetts hospitals in surge planning. Some surge exercises are local, at the level of a single hospital. In other cases, such as the Urban Shield exercises that Biddinger alluded to, hospitals, EMS, and state and federal health and public safety officials come together to drill on a single scenario.

High-Value Exercises

Emergency-preparedness professionals spend a lot of time imagining awful things. Boston EMS chief James Hooley says the scenarios from which he and his staff create so-called tabletop exercises (see Glossary of Exercise Terms on p. 5) have included bombs exploding at Fenway Park, lightning strikes in crowded places, and a serious subway crash in the midst of the Boston Marathon. “If we don’t think ahead about these things, we won’t be ready for them,” he explained.

A couple of years ago, Jonathan Gates, MD, director of trauma services at Brigham and Women’s Hospital in

A Glossary of Exercise Terms

- A *drill* practices one thing in isolation. Think fire drill.
- An *exercise* practices several moving parts. Exercises can be discussion based or action based.
- Discussion-based exercises include *thought exercises*. These are the spontaneous talking through of an emergency scenario such as a serious car accident with multiple injuries. “We’ll walk through the ED and ask physician and nurse leaders to think through how they would clear out their areas,” explained MGH’s Paul Biddinger. “Which patients would they discharge and which would they admit, and to which service?” That discussion would also involve the admitting department to make sure beds are available. Whether these spontaneous thought exercises are based on real or potential scenarios, Biddinger said, they keep everyone in the habit of thinking for disasters.
- A *tabletop exercise* is another frequently used discussion-based activity. As the name implies, this is an exercise in which people gather around a table to discuss what they would do in a given fictional scenario. Tabletop exercises among different hospitals and agencies in Massachusetts have led to broader and quicker disaster notification. “It used to be that hospitals wouldn’t hear about events until they were well under way,” said Biddinger. “Now, notification comes early so hospitals can activate their emergency systems quickly.”
- Action-based exercises also fall into 2 main categories. A *functional exercise* is one in which people are stationed where they usually work and figure out what they would do, for example, if there was a mass-casualty incident. “You don’t actually take the action,” explained Biddinger, “but you figure out what you would do. It’s really about communicating and sharing information within and between organizations.”
- A *full-scale exercise* is, in Biddinger’s words, “as close to the real thing as you can get.” People do what they discussed doing in the functional exercise. These activities usually involve multiple facilities and stakeholder agencies, make use of live actors and/or mannequins, and can cost \$20 000 or more to conduct at the hospital level, including planning, execution, evaluation, and personnel costs.

Boston, participated in a citywide full-scale exercise designed to show Boston’s EDs what it would be like to be overwhelmed with patients. The scenario was this: 3 “dirty” bombs had detonated on a plane at Logan International Airport. In several waves, Brigham and Women’s received about 40 “patients” who had to be triaged, decontaminated, and then rushed into surgery.

Gates learned 2 valuable things from this drill: first, that as much as he might want to or feel the need to scrub in to the OR to help with the surgeries, the system works better when he’s a conductor rather than one of the musicians. “Once I left my post as incident commander during the drill and went to the OR, the wheels began to fall off,” he recalled.

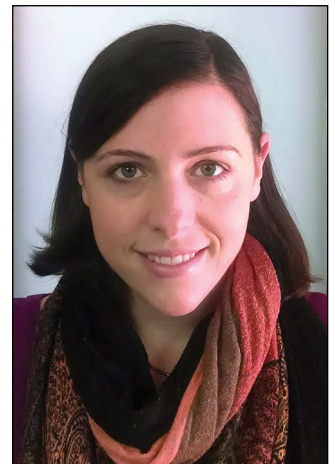
Blessed with what he calls a “deep bench” of surgeons ready for activation in an emergency, Gates identified another problem during the dirty-bomb drill: these surgeons were not easily contacted using the hospital’s existing page-operator system. That led to the formation of a surgical disaster page. “With 1 number, a page goes out simultaneously to a multidisciplinary team that includes surgeons, nurses, and residents,” Gates explained.

For Gates and others in the trauma world, the value of drills is that, “When you actually go through it, whether

it’s in a tabletop or full-scale exercise, you see where the holes are that need to be filled.” Having seen and filled these holes during previous exercises made the Brigham and Women’s response to the Marathon bombing much more effective than it would have been. Gates also sees opportunities to practice team-based disaster response during what he calls “true-live drills,” less-than-dire emergencies such as snowstorms.

For Mary Devine, emergency management coordinator at the Conference of Boston Teaching Hospitals (COBTH), 2 important live exercises in

Boston took place in 2002 and 2010. Both revealed what Devine called 2 giant issues—communication and patient tracking. “We plan exercises just like they were real events,” said Devine. That means providing hospitals with a mini-



Mary Devine, emergency management coordinator, Conference of Boston Teaching Hospitals

mum of information so they're surprised with new details within the scenarios.

From Devine's perspective, tabletop exercises are great at identifying gaps in existing plans and systems, or testing a new plan or system among a number of players. Generally, she recommends doing tabletops before committing to the resources and cost of a functional or full-scale exercise. "You want to make sure the plan is well known and in place before testing it live," she said.

According to BIDMC's Meg Femino, the July 2004 Democratic National Convention in Boston was the "first

Take-Homes From Femino

- Practice, practice, practice—feel free to use far-fetched scenarios but be clear about what you want people to learn. Practice low-frequency/high-impact events, such as active-shooter scenarios.
- Do all training and practicing in a no-fault environment.
- Have a high-level person in the organization responsible for emergency preparedness. "You need teeth to do this well," Femino said.
- Drill deep into your hospital systems; an occasional decontamination drill in the ED isn't enough.

Flexible Standardization

Almost everyone agrees that it's a good idea to standardize processes and procedures that have been proven to work. Whether on the factory floor or in the hospital ED, standards help people learn and know what they are supposed to do for optimal system functioning in different situations.

As good as standards are, though, they cannot account for all possible scenarios. When encountering a situation that hasn't been planned for or imagined, people often adapt on the fly. In football, the savvy quarterback looks at the defensive lineup and calls an "audible" from the line of scrimmage if the play planned in the huddle needs to be altered for successful advancement downfield.

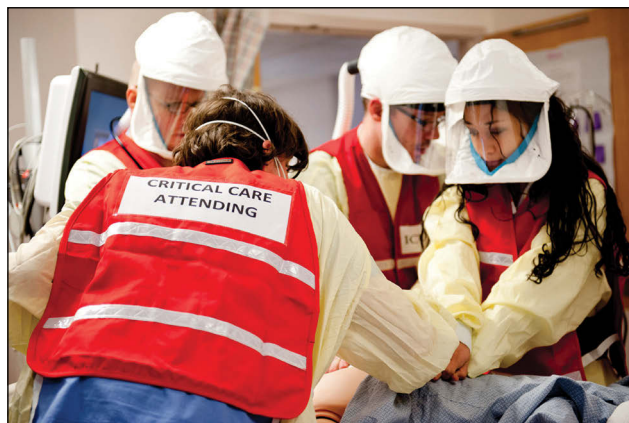
James Hooley, chief of Boston EMS, calls this flexible alteration of standards in the face of unusual events "annexing the playbook." No doubt, many lives were saved on April 15, 2013 due to adherence to standards in place throughout and beyond the EMS system. But annexing the playbook also helped save lives and limbs on a day when events unfolded that even the most imaginative what-if scenarios could not have predicted.

national special-security event since 9/11," and Boston preparedness officials started planning for it a year and a half in advance. The event raised interesting challenges, such as how to get patients, staff, and supplies from north of the city to Boston hospitals when the main southbound highway, Interstate 93, would be shut down near the convention venue. "The only way we could deal with that problem was with cross-disciplinary and cross-agency planning," said Femino.

Femino estimates that BIDMC participates in about 13 functional to full-scale drills and exercises each year. One of those simulated an evacuation of the neonatal intensive care unit (NICU) and involved local, state, and federal partners. (The feds were invited because of the premise that the NICU evacuation resulted from a plane crashing into the building.) The 3-day exercise utilized moulaged dolls, complete with ventilator bags, that had to be moved down 4 flights of stairs and then to other hospitals.

In 2012, BIDMC staged "Operation Contagion," a 5-day escalating exercise based on the scenario that 25 clinicians had unknowingly been exposed to pneumonic plague. Partners from the state DPH and the federal Department of Health and Human Services participated in this event, which included simulation mannequins that clinicians had to treat with breathing tubes and central lines while wearing full protective equipment in an infectious critical-care surge unit (see photo below).

According to Maureen McMahon, director of emergency management at Boston Medical Center (BMC), "Frequency of exercises is the most important thing. High-



A team wearing protective equipment treats a simulated patient who was exposed to pneumonic plague during "Operation Contagion" at Beth Israel Deaconess Medical Center in 2012.

ly exercised incident-management teams become almost Pavlovian in their response.” Because all events should test agility and require an element of critical thinking and rapid strategy development, BMC ensures that each exercise includes one unexpected twist that compels the players to think outside the box.

One of the largest mass-casualty exercises ever conducted at BMC was “Operation Ready” in May 2010, a simulated runway collision of 2 jumbo jets at Logan International Airport. Five hundred volunteer victims were evacuated from the planes, triaged, loaded into waiting buses and ambulances, and transported to area hospitals. By design, BMC was expecting 50 exercise victims, but an “error in direction” brought an additional 45 patients to the hospital. Using ORs, procedural areas, and associated recovery areas located on a single floor, the BMC team opened and staffed areas for pre-op stabilization, minor surgical procedures, major surgical procedures, recovery, and critical care. “The team thought it out, mobilized to create it, and made it work,” said McMahon.

One of the pre-Marathon tabletops at MEMA in 2012 considered multiple improvised explosive devices at the finish line. This exercise enabled discussion about who makes crisis decisions and how, and “how to communicate among command-level people spread out over a 26-mile course,” said MEMA director Kurt Schwartz. “We also debated about how to communicate with the public and how to divert runners who were still on the course.”

While this tabletop exercise was prophetically germane to the 2013 Marathon, Schwartz insists that “all the drills we’ve done had relevance to what happened at the 2013 Marathon.” He echoes others in the preparedness community who view each year’s Marathon as “an opportunity to do a full-scale exercise with all the terrible things that could happen in mind.”

Learning From Nonlocal Disasters

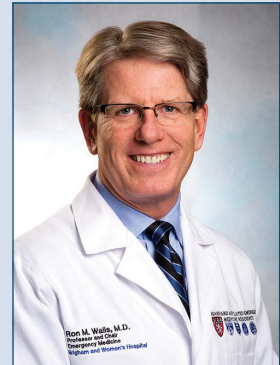
Because it’s hard to make time for just about any exercise, preparedness professionals try to learn from disasters wherever they occur. For example, after the Aurora, CO theater shooting in July 2012, Richard Zane, MD, chair of the Department of Emergency Medicine at the University of Colorado School of Medicine and former medical director of emergency management at the Brigham, sent his former colleagues 911 clips from first responders and encouraged his Boston counterparts to study them. Eric Goralnick, MD, Zane’s successor, and Emergency Medicine Chair

Learning Teamwork Through Simulation

Brigham and Women’s Hospital made a commitment about 3 years ago to train all trauma teams in its STRATUS Center for Medical Simulation. Medical simulation is often about learning specific interventional techniques, but the main goal of this simulation-based training is to learn effective teamwork and communication skills.

“It’s the nature of trauma teams to be constantly re-constituted,” said Ron Walls, MD, chair of the Department of Emergency Medicine at the Brigham. “We needed to establish a uniformity of understanding about how to function well when leading a team and how to be an effective team member.”

The Brigham requires its senior residents in surgery and emergency medicine to lead at least 1 team through a simulation before it considers them prepared to lead a trauma team in caring for a real patient, Walls said.



Ron Walls, MD,
chair, Department of
Emergency Medicine,
Brigham and Women’s
Hospital

Ron Walls, MD analyzed the clips, then shared the analysis with senior leadership, including members of the hospital’s board of trustees.

“We had never drilled to receive more than 14 people in the first hour, because ‘patients’ during those large, city-wide exercises were divided between several level 1 trauma centers,” observed Walls. “Our analysis showed that, although we had reached a high level of preparedness, we weren’t ready for 23 patients in 1 hour, which is what happened in Aurora.”

That realization led to a series of spontaneous functional drills, planned tabletop exercises, and retraining of the senior leadership in the hospital’s incident command structure. Relying on his military background, Goralnick often pulls surprise or spontaneous 15-minute drills, with no advance notice. Someone in a yellow observer vest enters the ED and yells, “This is a drill!”

“These exercises are good for getting people immediately engaged and focused on their initial response in an emergency, with the goal of minimizing impact on patient care,” explained Goralnick. “Participants learn to pull out

The DelValle Institute: Expanding Preparedness Education

The DelValle Institute for Emergency Preparedness was established in 2003, in the aftermath of 9/11, to help Boston prepare for hosting the 2004 Democratic National Convention. Its initial objective was to train first responders in metropolitan Boston, and DelValle's focus at the time was on chemical, biological, and nuclear threats.

Since then, the scope of DelValle's education-and-training mission has expanded to include just about every aspect of disaster preparedness. Also, as part of its growth, the institute—funded by federal health-preparedness and Homeland Security grants and housed at the Boston Public Health Commission (BPHC) in Boston EMS headquarters—has hired curriculum developers who work with subject-matter experts to deliver effective training courses, live and online. Course offerings range from the technical (mass-casualty triage, for example) to interactive online courses for children in video-game formats.

DelValle senior program manager Brian Pomodoro and his colleagues are looking at “blended” alternatives to multiday live courses. “We can cut a 3-day live class to 2 days with an online module taken before day 1,” he explained.

Mea Allen, the associate director for education and training at the BPHC's Office of Public Health Preparedness, manages the operations of the institute. She has led efforts to leverage technology to meet the needs of public health, health care, and community partners. “Mea has been visionary in the design, development, and implementation of the DelValle Learning Center,” said Atyia Martin, who oversees the institute in her role as director of the Office of Public Health Preparedness.

Most DelValle courses are open to anyone, private citizen or public employee, and there's an overarching concern for informing and reaching out to vulnerable populations. “We keep the most vulnerable populations as a forethought, not an afterthought,” said Martin, who shifted her professional interests from homeland-security intelligence to emergency management after witnessing what happened in New Orleans during and after Hurricane Katrina.

The DelValle Institute is fiercely outcomes based. “It's about helping people apply theories and concepts to real-world, practical situations that they face in their work,” emphasized Martin.

Like everything else in this emergency-preparedness environment, DelValle courses are continuously improved with after-class evaluations. Stakeholders in the preparedness community and class attendees discuss what went well during a course and what needs improvement.

and use the right checklists, decide who needs to be called, and who the incident commander should be.”

The Link Between Exercises and Training

While the customary approach to preparedness training is to do classroom or tabletop exercises first and then practice the cognitive learning with drills, the opposite approach can be useful. LT Brian Pomodoro, field supervisor for Boston EMS and senior program manager at the DelValle Institute for Emergency Preparedness (see sidebar), will often hold an exercise first to identify where the gaps are, then to address those gaps in a classroom/tabletop setting, and finally to redrill to make sure the information stuck in both mental and muscle memory.

Pomodoro does acknowledge that full-scale functional exercises are expensive and disruptive, but he said that smaller-scale drills that test and practice a single task, such as applying triage tags, are effective and can be done on an as-needed basis without high expense or huge schedule disruptions.

Whether training fellow EMS colleagues or hospital or agency groups, Pomodoro updates trainings based on



Brian Pomodoro, senior program manager for response training, teaches a class at the DelValle Institute for Emergency Preparedness. Pomodoro was a first responder to the Marathon bombings on April 15, 2013.

lessons learned from previous disasters, both near and far. When Pomodoro and his colleagues studied the response to the London subway bombings in 2005, they identified secondary triage and moving injured people without stretchers as gaps, so they added these areas to the curriculum.

“Our secondary triage exercise now consists of note-cards with explanations of patient injuries and Tupperware bowls representing ambulances,” said Pomodoro. To address the possibility of stretcher shortages in a disaster, a course module in safe methods of carrying injured patients using mannequins was implemented.

Patient distribution to hospitals was also not very efficient in London after the subway bombings, so EMS developed curricula in that subject, and astonishingly effective patient distribution was an oft-cited success after the Marathon bombings.

Terry Gustus, DPT, rehab services manager at NWH, understands the need for both mental and physical pre-

paredness. “I personally need both the cerebral and the physical components,” Gustus said. The latter, she said, is important to develop muscle memory and basic but crucial knowledge, such as where she should be standing.

One physical exercise that Gustus found very useful involved setting up and taking down the hospital’s mobile decontamination unit, which Gustus described as a series of mobile tents usually set up by local fire department personnel on or near hospital grounds. “As emergency management staff, it is important for us to know the safe and correct methods of decontamination,” Gustus said. “Communication with those going through the process is key to keeping staff and the public calm.”

Chapter 3

The Keys to Communicating

In an emergency, the 3 critical issues are communication, communication, and communication,” said the Brigham’s Eric Goralnick, MD. Communicating clearly and effectively, of course, is much easier said than done, and it prompts 2 related questions: what to communicate and how.

Situational Awareness

Situational awareness is a term that arises in the what-to-communicate department. The term is one of many used in the emergency-management community that has its origins in the military. Like the fighter pilot who has to know who and what is where in the air, friend and foe, emergency responders need to know how many patients, what type (elderly or pediatric, for example), what hazards might be present in the field and for clinicians, and what basic resources are available, including

“Situational awareness, and communicating that information from point A to B, is the single greatest challenge in any disaster.”

humans, space, and blood. In the emergency-response context, situational awareness also involves the capacity to predict what might happen in the next 5 or 10 minutes.

“Situational awareness, and communicating that information from point A to B, is the single greatest challenge in any disaster,” said MGH’s Paul Biddinger. “It’s a matter of sizing up the needs of the situation and matching them up to the available resources for an effective response.”

In her role as emergency management coordinator for COBTH, Mary Devine’s job is to be a net for situational awareness information and to communicate it not only to COBTH’s 14 member hospitals but also to the state DPH, Boston EMS, the BPHC, and the mayor’s office. Devine sees herself as the information gatherer, a funnel for capturing information and delivering it when and where needed. It’s a challenging role, but one that proved pivotal on April 15, 2013.

Biddinger’s Biddings

- Understand your primary role/responsibility in an emergency. People need to know automatically where to go.
- Know from whom you will get direction and information. “There’s a lot of barking during a disaster,” said Biddinger. “You need to know who to listen to and who you can ignore.”
- Exercise, exercise, exercise. A large level 1 trauma center like MGH should do a minimum of 3 to 5 full-scale exercises a year and a minimum of 5 to 10 tabletop exercises a year.
- Be broad and collaborative in your planning and exercising. Said Biddinger, “If you don’t go beyond the ED, you’ll fail.”
- Don’t enforce too much structure at the scene of a disaster. First responders at the Marathon bombings cleared the scene of all critical victims in 18 minutes. “That may not have happened so quickly if Boston EMS had rigidly adhered to traditional triage and transport protocols,” said Biddinger.

The Role of Technology

One technology component that preparedness and disaster-response officials rely on for clear, timely, and accurate communication is the WebEOC, a statewide, web-based crisis information network for health care entities. The DPH’s WebEOC is 1 of 3 WebEOC systems that are monitored during every Boston Marathon. The DPH system focuses on health and medical situational awareness statewide, the city of Boston maintains a WebEOC for its operations, and MEMA also has a statewide WebEOC.

Access to the system is restricted at each facility, and users receive training in how to use it. Because of the risk of misinformation being posted on the WebEOC, postings are often vetted by a facility’s emergency-response leader so that WebEOC users are assured of accurate information.

A more 1-way but equally important emergency-alerting technology in Massachusetts is the Health & Homeland Alert Network (HHAN). This notification and

alerting system pushes out information to users via computers, phones, and pagers. The HHAN does not collect information, but it does disseminate it and confirms receipt of messages. The state DPH oversees HHAN, and its 13 000 users in Massachusetts include officials in public health, hospitals, community health centers, emergency preparedness, and the volunteer Medical Reserve Corps. DPH keeps HHAN access somewhat narrow to prevent slowdowns in message communications. On the day of the Marathon explosions, 40 000 devices were pinged with 150 separate messages. HHAN activity waned temporarily after that until Friday, April 19, the day of the manhunt, when HHAN delivered another 20 000 pings.

The WebEOC and HHAN are emergency-communications systems with designed interoperability. But disaster-response officials rely on many other communication systems, and as MEMA director Kurt Schwartz pointed out, system interoperability is a key to strong multi-agency /multijurisdictional coordination. Before the bombs went off on April 15, all first-responder supervisors working the Marathon could talk to one another, regardless of their discipline or specialty. All command-level personnel within and across each jurisdiction could talk to one another also, and to the MEMA-housed Multi-agency Coordination Center (MACC). In addition, all the individual hospital emergency operations centers, the DPH Operations Center (DOC), and the Stephen M. Lawlor Medical Intelligence Center (MIC)—managed by the Office of Public Health Preparedness at the BPHC—could talk to the MACC. “We weren’t all in the same place, but we coordinated our communication well,” said Schwartz.



Kurt Schwartz, director,
Massachusetts Emergency
Management Agency

On any given Marathon Monday, Boston EMS has staff on foot, in golf carts, and on bikes along the Boston section of the Marathon course, which covers a large and busy portion of the city. To make rapid and clear communications work in the field, EMS personnel have radios with dedicated channels. Rapid communication of what EMS commanders and coordinators see in the field is facilitated by EMS personnel stationed in

the MIC in Boston and at the MACC. “Having a representative from each organization in the various command centers on the day of the Marathon or any other planned mass-casualty event ensures quick information relays,” noted Boston EMS chief James Hooley.

Boston’s embarrassment of riches in terms of health care resources “makes coordination and collaboration even more important,” said the BPHC’s Atyia Martin. “If people don’t communicate in this environment, the potential for chaos is even greater than in a scarce-resourced situation.” COBTH’s Mary Devine agreed. “The high concentration of hospitals in Boston makes communication and collaboration even more essential,” she said. “Anything that affects one hospital will affect them all.”

Integrating Incident Command Systems

In an emergency, who communicates is often as important as the message communicated. Effective communication was one rationale for the adoption of incident command systems (ICSs) in the preparedness and response communities. The streamlined communication within an ICS facilitates effective responses in many ways.

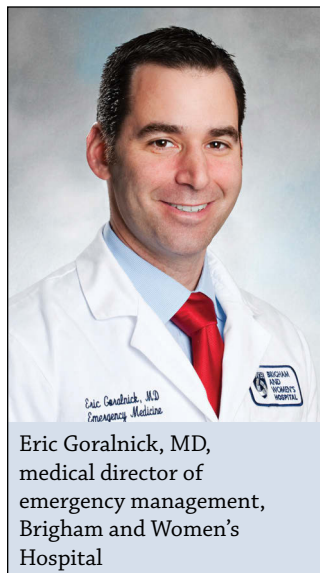
The ICS concept comes from the military. Often, disaster scenes, whether caused by weather events or human actions, look like war zones, or “as if a bomb went off.” These allusions to military conflict translate into the way hospitals and governments prepare for such disasters—most rely on an incident command structure that mimics the chain-of-command framework that makes military plans and tactics standardized and effective.

The ICS concept gained status in the civilian arena after the confusion in emergency response to California wildfires during the 1970s. To remedy the chaos, firefighting organizations designed response systems in which people had clearly defined roles and spans of control.

The clear chain of command and reporting structures inherent in an ICS help maintain a sharp focus on priorities. “The idea is to make sure anyone in a response capacity understands standard terminology and can participate in the response in an organized way,” said the Brigham’s Eric Goralnick, who is also a senior associate at the National Preparedness Leadership Initiative, a collaboration of several schools at Harvard that trains senior leaders in preparedness.

The ICS concept spread among East Coast emergency responders in the 1980s after the 1982 Air Florida crash into the Potomac, and in the early 1990s Orange County,

CA hospitals implemented a regional ICS. The ICS structure eventually spread throughout the US hospital system and became known as HICS, with the “H” standing for “hospital.” All accredited hospitals in the United States are now required to implement their own HICS.



Eric Goralnick, MD,
medical director of
emergency management,
Brigham and Women's
Hospital

Goralnick said HICS “frames the response to an emergency, so you can flip the switch from a matrix organization with a variety of reporting structures to a streamlined organization with the right people in the right position to respond in a fluid, effective manner.”

The role of each member of the HICS team is usually spelled out in written guidelines. At NWH, for example, there are 50 different roles within the HICS, about 14 of which are typically activated every

Marathon day. These roles include an incident commander (usually a senior-level physician), a medical officer and unit leader in the minor treatment area, a safety/security officer, the emergency management coordinator, an operations officer (usually a nurse supervisor), and members from logistics/supplies, transport, the ED, patient tracking, dietary, and public information.

As an organization’s communications spearhead, the public affairs function needs to be well versed in the incident command structure and to assign a communications officer to be part of that structure. Although public affairs is often thought to be an entity communicating only with external stakeholders, Eric Goralnick emphasized that the role is also crucial for “key messaging across the organization internally.”

According to NWH’s Charlotte Roy, who is responsible for training HICS team members, the HICS approach works well because everyone knows his or her defined role, from whom he or she gets direction, and with whom he or she needs to communicate. “We use our incident command system quite a bit,” said Roy, emphasizing that HICS can be activated for an impending snowstorm or whenever any area of the hospital is overwhelmed and needs additional help. Not waiting until a disaster of huge

proportions happens to activate HICS means that “people become more comfortable with the system and aren’t afraid of it,” she said.

Tufts Medical Center’s Rob Osgood agreed. Tufts activates HICS for any incident outside normal medical center operations, he said. That might include citywide sports team celebrations, severe weather, national medication shortages, or influenza outbreaks.

One of the many challenges for the BAA’s medical coordinator, Chris Troyanos, is to make sure that the individual hospitals’ ICSs meld smoothly with one another during the Marathon. The WebEOC helps tremendously in this regard, but he said the best way to ensure understanding and interoperability of these nested systems is to “practice, practice, practice.”

The DOC, the MIC, and the MACC

The DPH’s DOC monitors Marathon activities outside the city of Boston and coordinates communications with all of the course hospitals. It’s staffed and operational from 7:00 AM on the day of the Marathon, and in 2013 it remained activated through April 26. “We also co-located DPH staff at the Medical Intelligence Center [MIC] starting the day after the Marathon through April 26 to connect the work of BPHC with work in the surrounding communities, particularly in terms of mental health support,” said the DPH’s Mary Clark.

The MACC at MEMA headquarters makes sure all the local, state, and federal prerace planning comes together on Marathon day. The MACC is usually activated from 6:00 AM until 6:00 PM on race day and typically houses about 90 people, including police, fire, and EMS officials from all 8 cities and towns, and representatives from the BAA, DPH, state police, National Guard, and state Department of Transportation. Federal representatives from the FBI, Department of Homeland Security, and other agencies are also in the room.

As a communications hub, the MACC permits instant exchange of information, rapid problem solving, and coherent situational awareness. “If something is happening in Hopkinton, the race’s start point, people in Boston know about it immediately,” said MEMA’s Kurt Schwartz.

The MACC also ties together communications among the 20-plus medical stations along the Marathon route and is a central dispatch point for ambulance services. The dispatch of ambulances after the 2013 bombings was concentrated in Boston, but during the “hot race” of 2012, the DPH-staffed health and medical desk worked with the De-

partment of Fire Services at the MACC to monitor ambulance comings and goings because the need for emergency transport occurred all along the Marathon route.

The MIC at the BPHC is another communication hub, more localized than the MACC. The MIC's main job is to coordinate information, resources, and human services. Incoming information and requests from public health, EMS, health care, and public safety are synthesized, analyzed, and disseminated to provide a comprehensive common operating picture. The information also provides public health and health care partners with key updates from other emergency-support functions such as law enforcement and transportation.

On Boston Marathon days, the MIC's primary objective is to provide technical assistance for the emergency tracking system deployed in the field, to track injured runners and provide ongoing situational awareness and support to public health and medical services. On April 15, 2013, one large screen at the MIC had the WebEOC displayed on it and another streamed live media coverage. A third screen scrolled the schedule of events for the day, including conference calls and situation briefings.

The MIC was activated nonstop from April 15—customary activation for any Marathon—until April 26. The incident command structure in the MIC places 1 incident commander in charge, who makes sure all the information is collected and prepared for standardized “situational briefings,” which summarize what happened, what the current situation is, and what anticipated actions will be.

During the first few days after the Marathon bombing, representatives from nearly every health and human services entity responding to the tragedy had a seat in the MIC. “When you’re in the room with other representatives from partner organizations, decisions happen so much faster,” said Atyia Martin, director of the Office of Public Health Preparedness within the BPHC.



Atyia Martin, director,
Office of Public Health
Preparedness, Boston
Public Health Commission

Chapter 4

The Importance of Relationships

The same public health and safety officials who critiqued the 2004 Marathon were willing to work with the BAA's Chris Troyanos to plan for future planned mass-casualty events. So he set out to cement those relationships and educate all the stakeholders about how they could coordinate their efforts. "Knowing exactly what the different stakeholders are responsible for and capable of doing has made a huge difference in recent years," Troyanos said. "Making sure all these people have input on the planning end and thanking them afterward goes a long way toward making Marathon day as safe as it can be."

Troyanos goes about building and maintaining these multidisciplinary, multisystem relationships the old-fashioned way: he arranges meetings with key leaders and talks things over face to face. The question he asks repeatedly is, "How can we help each other?"

Since 2004, Troyanos and his core team have enlisted the emergency-preparedness heads at the 10 Marathon-related hospitals in the web of necessary preparedness relationships. "During pre-Marathon planning every year, the hospital emergency-preparedness directors encourage their emergency department heads to attend the planning meetings so we can discuss how to work better together," Troyanos said.

In addition to their overriding concern for the well-being of runners and spectators, what makes the hospitals so willing to work with the BAA is Troyanos' team's respectful attitude toward preparedness leaders and their systems. "We're playing in the sandboxes of 8 different cities and towns on Marathon day," Troyanos said. "It behooves us to work cooperatively to make sure the BAA medical program meshes with the systems and protocols of the hosting communities and hospitals."

In addition, different hospitals and communities have differing incident command structures, and Troyanos and his 55-person Marathon medical committee have become familiar with—and respectful of—those systems to ensure

an integrated response to mass casualties, whether they arise from hot weather or an improvised explosive device.

This carefully cultivated respect made it easier for Troyanos and his team to urge hospitals prior to the 2012 Marathon to adopt newly recommended protocols for cooling overheated runners. Research suggested that gastric lavage and ice packs did not provide rapid-enough cooling to prevent cell damage in severely hyperthermic individuals. So the BAA medical committee encouraged all emergency responders to determine patients' body temperatures rectally, and to use immediate ice immersion to cool those whose body temperature was above 104°F and who showed mental-status changes. The BAA even offered to supply the thermometers, tubs, and ice.

Boston EMS, the private ambulance companies serving the cities and towns along the Marathon route, and all the hospitals agreed to the protocols, and many accepted the BAA offer of supplies. "That year, hospital EDs iced down many people that we couldn't get to quickly enough in the medical tents, and once again there were no fatalities," Troyanos said.

For the high level of preparedness at NWH, Charlotte Roy partly credits the close working relationship hospitals have with the BAA and Troyanos. During yearly pre-Marathon meetings with all the hospitals on the route, BAA physicians Sophia Dyer, Aaron Baggish, and Pierre d'Hemecourt update NWH staff about the latest advances in treating hyperthermia and hyponatremia. Troyanos briefs hospital staff on where the medical tents along the route will be located and what their capacities and capabilities are. "The BAA's support has helped our ED in ways that go beyond treating Marathon runners for race- and weather-related injuries," said Roy.

The legacy of respect and relationship building among the whole Massachusetts preparedness community has paid off during 16 presidential disaster declarations in the state since 2005. Fourteen of those were weather events;

"The BAA's support has helped our ED in ways that go beyond treating Marathon runners for race- and weather-related injuries."

Preparedness for Vulnerable Populations

Anyone directly affected by a disaster automatically becomes a member of a “vulnerable” or “disadvantaged” population. But what happens during emergencies to people who are already at risk?

That question is what got Terry Gustus, DPT, rehab services manager at Newton-Wellesley Hospital (NWH), involved in emergency preparedness. Charlotte Roy, the hospital’s emergency management coordinator, was seeking colleagues interested in vulnerable populations to join the hospital’s preparedness committee. Gustus, who had a personal interest in people with vision impairments, volunteered. She acknowledged that preparedness efforts sometimes overlook people with sensory, mobility, and cognitive impairments.

Thanks largely to Gustus’ advocacy for people with functional needs, in 2008, when NWH received several patients after a subway crash in Newton, the ED had mobility aids and assistive devices on hand for people who were not severely injured but previously impaired by visual or motor deficits.

With Gustus’ awareness of the at-risk population, during one drill in the decontamination unit, she realized that there were no seats for people who might need them while being washed down. Now the decontamination tent includes shower chairs that can be used for undressing, showering, and dressing.

Gustus, who has become proficient in American Sign Language to assist people with hearing impairments, said, “In any emergency, it’s important to expand your definition of ‘special needs’ to include people who are homeless or critically ill or who don’t speak English, and to understand the scope of needs these people have in disasters.”

the other 2 were a massive water-main break in 2010 and the 2013 Marathon. “In Massachusetts, local, regional, and state officials work well together,” observed MEMA director Kurt Schwartz. “There’s also a good relationship between public safety agencies and elected officials, including the governor and mayors.”

A critical success factor is the preparedness community’s knowledge of one another’s capacity, capability, and roles. According to the DPH’s Mary Clark, that awareness is due in large part to the long-time relationships among people in the readiness and response communities.

Preparedness plans involve the same roles (and often the same people) and the same systems for all events, from the Marathon, to celebrations such as World Series cham-

pionships and July 4, to national political conventions. “We’re a community that works together frequently,” said MEMA’s Schwartz.

However, while Clark, Femino, Schwartz, and many of their colleagues have spearheaded preparedness efforts for decades, turnover and retirements do take place. In fact, on the day of the Marathon bombings, a newly appointed interim DPH commissioner was out of the state, and the interim deputy commissioner had to step into the incident command structure and effectively coordinate the DPH activities during her first week. “That’s why our organization relies on clear emergency preparedness and response policies and procedures,” said Clark. “We need people to respond to the DPH, not to me or any other individual.” Added John Grieb, Clark’s deputy, “You need a deep bench, so any number of different people can step up and know what to do.”

Having said that, Clark nevertheless agreed that “it’s comforting to deal with someone you know.” And Katie Kemen, a DPH emergency planning coordinator, said, “Strong personal relationships help ensure that we know the people behind the roles, and prior relationships help us get people’s attention.”

Frequent contact via regular meetings with hospitals and local and regional emergency coordinators helps as well. Prior to the day DPH officials were interviewed for this special report, Kemen had spent 10 consecutive working days out of the office in preparedness meetings around the state, cultivating and maintaining those key relationships.

Having the Conversations

Within the city of Boston, much of the public health and health care preparedness relationship building is spearheaded by the Office of Public Health Preparedness, a division of the BPHC. Preparedness director Atyia Martin describes her team as “facilitators of information and resources.... We bring people together to collaborate and have conversations about emergency preparedness.”

The Boston Healthcare Preparedness Coalition is a key vehicle the Office of Public Health Preparedness uses to bring together representatives from public health, EMS, hospitals, community health centers, long-term care facilities, home health and mental health agencies, dialysis centers, and university health centers in and around Boston. The coalition’s goal is to facilitate coordination of response and recovery planning, training, exercises, and evaluations. It also provides input on the multi-agency co-

ordinating function of the MIC, as well as education and training for the DelValle Institute. BIDMC's Meg Femino is the coalition's chair, and Stacey Kokaram, an associate director for the Office of Public Health Preparedness, is its co-chair.

While effective partnerships are built on the foundation of conversations, sometimes in the emergency-preparedness world those conversations focus on what Atyia Martin calls "stuff and toys," the sexier, equipment side of the discipline. "We make sure people are talking to each other about more than stuff," she said. "The equipment and technology are a small piece of the larger preparedness picture, which includes people, planning, training, and exercising."

Martin added, "We could have had all the 'stuff' in the world in the MIC on the day of the bombings, but if we didn't have those people in the chairs, facilitating and coordinating resources based on plans, training, and exercises, it would have been all for nothing."

Martin's 15-person office interacts with more than 100 partners, including hospitals, community health centers, and long-term care facilities. To build and maintain relationships with so many organizations and people requires a lot of outreach and cold calling. "The conversation begins,

one call at a time, one meeting at a time, one plan at a time," Martin said.

Over at COBTH, the creation of the emergency preparedness coordinator position after the 9/11 attacks helped cement the collaboration among the emergency managers at the Boston hospitals that had begun with a disaster management committee that COBTH formed in the 1980s. "It's always a challenge to maintain a culture of inclusiveness when you're dealing with 14 separate hospitals," said COBTH's Mary Devine. "Needs and resources at each hospital are different, and it's hard to make sure that preparedness exercises are relevant and helpful for everyone."

For example, Dana Farber Cancer Institute, one of the smaller COBTH members, doesn't have an ED—and EDs are understandably the focal points of many disaster drills and exercises. But when a massive water-main break occurred in 2010, the impact on Dana Farber was greater than that on the other member hospitals, because cancer chemotherapy is a water-intensive process.

During disasters like the Marathon bombings, it's easy to see the collaborative fruits of relationship building. But Devine emphasized that "collaboration happens daily. The many preparedness projects we do together make collaboration an ongoing thing."

Chapter 5

Preparedness Leadership

As in any other endeavor, a walk-the-talk commitment from senior leaders is a prerequisite for organizationwide buy-in to preparedness programs.

Paul Biddinger from MGH is a well-recognized disaster-preparedness leader in Massachusetts and around the country. But he insists that preparedness leadership must be displayed at all levels. “You may not be the incident commander at your hospital, but if you’re an operations chief or unit director, you still need to display sound leadership in an emergency,” he said. And even if you are your organization’s incident commander, he added, “you need to lead outside your organization, with other organizations. This kind of ‘meta-leadership’ helps the whole system function well.”

Preparedness leadership also ensures that the intensely competitive relationship among Boston-area hospitals is cast aside, at least in 1 area.

As a health care market, eastern Massachusetts is a highly competitive place. The bombardment of advertising from hospitals and health systems makes one wonder how these competing institutions could possibly work cooperatively rather than competitively. It does happen, though.

“Each academic medical center in this part of the country thinks it’s the best,” concedes Biddinger. “But we’re noncompetitive when it comes to preparing and responding to emergencies. The hospital emergency managers, especially, talk to one another openly and share their ideas and plans all the time.”

At Brigham and Women’s, the emergency leadership triad consists of Eric Goralnick, MD, medical director of emergency management; Barry Wante, emergency management director; and Nancy Hickey, MSN, an associate chief nursing officer. “It’s critical to have these various disciplines represented to ensure readiness,” said Goralnick.

Goralnick’s job, as he sees it, is to champion preparedness among 15 clinical departments across several sites in

order to “focus everyone on the critical role of preparedness in our daily lives.”

Early in 2012, preparedness leaders Walls and Goralnick realized that the Brigham had undergone major changes in senior leadership, with new people in key positions such as chief medical officer, chief nursing officer, and chief operating officer. Although generally familiar with ICSs, these leaders were new to several critical roles in the hospital’s ICS, and they needed training in how to perform within those roles. The new leaders began receiving their ICS training prior to the Aurora, Colorado shooting

in July of that year, but training intensified after the Colorado tragedy.

NWH’s Charlotte Roy deems herself lucky to have ample support from the hospital’s president, chief operating officer, and senior vice presidents. Meg Femino at BIDMC might be even luck-

ier. The “fantastic engagement in preparedness” that she sees across the medical center is attributable largely to the fact that her position reports directly to a senior vice president. “This position is not buried,” she said. “It has been elevated to a pretty high level in the hospital organization.”

In addition, BIDMC funds preparedness activities out of its operational budget. This umbrella of high-level support helps change the way the organization views drills and exercises. Explained Femino, “When I got here, people were afraid drills might make them or their department look bad. Now people clamor to be involved, and because of that people know where to go and what to do in an emergency.”

Despite the Marathon bombings and several other incidents in Boston in 2013—a major blizzard, Superstorm Sandy, and a bus crash—people still need to be reminded of the importance of preparedness activities. “There’s never enough time on anyone’s schedule for this work,” lamented COBTH’s Mary Devine. “That makes the active support of senior leadership even more critical.”

“Because many components of preparedness are disruptive and expensive, senior leadership has to be completely committed to devoting the time, resources, and communication systems to the process.”

“Because many components of preparedness are disruptive and expensive, senior leadership has to be completely committed to devoting the time, resources, and communication systems to the process,” agreed the Brigham’s Ron Walls.

Finally, Brian Pomodoro’s experience as senior program manager at the DelValle Institute has proved that

senior-management participation in training is the best way to drive organizational buy-in to the concept of continuous learning. “When we train captains and lieutenants first, they go back to the rank and file and sell the concepts to them,” observed Pomodoro. “The message senior administrators need to convey is that training is not a one-shot deal.”

Part 2: Response and Recovery

April 15 Through December 31

Chapter 6

April 15, 2013

We all know what happened the afternoon of April 15, 2013. The events were well chronicled in the media, and many people who witnessed, were injured in, or responded to the tragedy have told their personal stories. The following behind-the-scenes vignettes reveal a deeper glimpse into what many people did that day and in subsequent weeks and months—and what they learned from the experience. The themes of heroism, compassion, and teamwork play out in all the stories.

At the Scene

This was the third year that Irene Davis, PT, PhD and her husband Darrell, a former Special Forces serviceman, had volunteered in the “heat section” of the main medical tent at the Marathon finish line. Irene is director of the Spaulding National Running Center, and her husband had experience treating heat-related injuries in the military.

The Davises were the second people to help Michele Mahoney, who was at “ground zero” of the first explosion. Mahoney came out of the carnage alive but with a fractured fibula, ruptured Achilles tendon, deep tissue shrapnel wounds to her calf, and burns. Michele’s close friend, with whom she was standing at the finish line, lost both his legs in the blast.

When the Davises saw Michele’s injuries, they covered them so Michele couldn’t see them. “I suggested to the triage person that she should go immediately,” recalled Darrell, but because Michele had both her limbs still attached and didn’t appear to be in immediate danger of bleeding out, she was assigned a #3, the lowest number in the 3-stage triage system used in the tent.

But Mahoney didn’t end up waiting long. The Davises noticed she was losing some of her color, and they found it



First responders transfer people injured in the Marathon bombings into waiting ambulances. The street in the immediate vicinity of the explosions was cleared of all injured people in only 18 minutes. Photo credit: *Boston Globe/Getty Images*.

difficult to find a pulse in her foot. A cardiac surgeon in the tent examined Michele and swapped her #3 for a #1. With her new high-priority designation, Mahoney was rushed to the emergency department (ED) at Beth Israel Deaconess Medical Center (BIDMC). The Davises were pretty sure she’d lose a foot.

Irene Davis found Mahoney’s composure during the medical-tent and triage ordeals remarkable. “She always thought about the person next to her who was worse off than she was,” recalled Irene. Mahoney remembers being anguished mostly about her friends.

“Irene held my hand, told me to breathe deeply, and that she’d stay with me until an ambulance came,” said Mahoney. That contributed to her ability to stay calm. Also, she said, “I had seen my friend’s legs blown off and a pile of people who looked dead, so I knew there were others worse off than me.”

The seasoned veterans from Boston Emergency Medical Services (EMS) had never seen anything like the injuries sustained that day. “Our people are trained carefully to a plan, but we also give them the tools and authority to improvise, if necessary,” said Boston EMS chief James Hooley. Such improvisation was indeed necessary after the bombings. The street was cleared of all injured people in an amazing 18 minutes. Many EMS ambulances deviated from standard protocols by transporting up to 3 or 4 patients in a single ambulance.

For security reasons, police wanted the main medical tent—where many of the injured were staged—cleared out as quickly as possible, increasing the need to, in Hooley’s words, “annex the playbook” of transportation protocols.

Normal transportation procedures also were overridden when injured people flagged down an ambulance that was otherwise engaged. “You have to adapt on the fly in those cases,” said Hooley. “You pick them up, inform CMED [Centralized Medical Emergency Dispatch], and take them where you’re told to.”

In these unforeseeable situations, Hooley said, EMS personnel kept the overall goal foremost in mind: “Do as much as you can for as many as you can.”

At Brigham and Women’s Hospital

The timeline on page 21 summarizes the sequence of events at Brigham and Women’s Hospital on April 15.

After the bombings, the Brigham’s director of trauma services, Jonathan Gates, MD, reached orthopaedic surgeon Mike Weaver with a disaster page and asked him to call in as many orthopaedists as he could. “We had 9 here immediately,” Gates recalled.

In fact, the biggest challenge at Brigham and Women’s and other Boston hospitals that day was coordinating the inflow and supply of these additional human resources. “More

trauma teams than we needed were assembled,” said Ron Walls, MD, the hospital’s emergency medicine department chair. “We were able to provide an immediate resuscitative response for 8 or 9 people at the same time, but the sheer volume of clinicians was overwhelming for a while.”

Another challenge was patient identification on arrival and tracking Marathon patients in the hospital in the first hours. “Intrateam communication in the ED and communication with other clinical units, such as the ICU and

the surgical suite, was great,” Walls said, but prioritizing patients for critical limited resources, such as consultants, the CT scanner, and the next available operating room (OR) was more challenging. Coordinating that

required an improvised “on the ground” leadership team, representing emergency medicine, trauma surgery, and the OR, including anesthesiology.

Resuscitations proceeded rapidly and with remarkable order. As an almost eerie manifestation of the Brigham’s renewed preparedness focus in the wake of the Aurora, CO shootings, 23 patients arrived in the first hour after the bombings, precisely the number that had caught the attention of Walls and the Brigham’s medical director of emergency management, Eric Goralnick, MD, almost 6 months earlier (see page 7).



Meg Femino, director of emergency management, Beth Israel Deaconess Medical Center

At Beth Israel Deaconess Medical Center

BIDMC director of emergency management Meg Femino and her 2 full-time project directors were alerted to the bombing through a page on the Health & Homeland Alert Network. Less than a minute later, another alert indicated that 30 to 40 people had been “red tagged” with serious injuries.

Minutes later, Femino received a message from Mary Devine, the emergency management coordinator of the Conference of Boston Teaching Hospitals (COBTH). Call-



Jonathan Gates, MD, director of trauma services, Brigham and Women’s Hospital

Brigham and Women's Hospital Timeline, April 15, 2013

08:00	Per standard Marathon Day procedures, the Brigham and Women's Hospital Emergency Operations Center is partially activated.
14:49	Scan of the emergency department (ED) shows 66 patients in the 55-bed ED and 30 of 42 operating rooms (ORs) active or in use.
14:50	Reports of the explosion heard over Boston EMS/Fire radio frequencies.
14:54	Hotline from Centralized Medical Emergency Dispatch (CMED) rings in ED, reporting 2 explosions and incoming patients. Emergency medicine physician, nurse in charge, and emergency-management director huddle to implement "Code Amber," the hospital's mass casualty incident plan. Call from the Medical Intelligence Center (MIC) at the Boston Public Health Commission informs hospital that it will soon receive 8 patients from the scene.
14:59	Nurse in charge mobilizes providers to ready multiple operating rooms.
15:00	Trauma Service notified of explosion. Phone tree notifies orthopaedic surgeon, neurosurgeon, chief resident in surgery, OR front desk, and all 7 trauma surgeons in the hospital that day.
15:08 to 15:38	Nineteen bombing patients arrive, each of whom is assigned a multidisciplinary team to conduct trauma surveys and perform resuscitations, intubations, and blood transfusions if necessary.
15:15	OR medical director huddles with orthopaedic, emergency medicine, and trauma team leaders to coordinate direct flow into ORs for most seriously injured patients, bypassing preoperative areas.
15:30	Core leaders of orthopaedics, trauma, and anesthesiology assembled.
15:39 to 16:38	Brigham and Women's Hospital receives 7 more bombing patients.
16:00	Senior general surgeon positioned in ORs to facilitate surgical administrative issues.

Overall, Brigham and Women's Hospital treated 40 Marathon patients. Nine required immediate operative intervention. Citing preparedness training, drills, and exercises, Drs Eric Goralnick and Jonathan Gates wrote in "We Fight Like We Train" (*NEJM*, May 1, 2013) that success came from "colleagues working alongside familiar teammates performing familiar tasks." Timeline adapted from "We Fight Like We Train," *NEJM*, May 1, 2013.

ing from the Medical Intelligence Center (MIC), Devine said that there had been 2 explosions and the race had been diverted. "As soon as I heard about the second explosion, I concluded to myself that this was an act of terrorism," Femino said, a hunch that of course turned out to be true.

The first Marathon patient arrived at BIDMC only 11 minutes after the explosions, and the hospital received 10 red-tagged patients within 37 minutes. Overall, the hospital received 24 patients injured by the explosions—10 red, 6 yellow, and 8 green.

The hazmat tent was set up as soon as the first alert came in, but "we had intelligence from people with dosimeters at the scene that there was no radiation," recalled Femino. "If there had been biological exposures, we could have treated those after saving lives, so the critical patients were brought directly inside."

Meanwhile, the stretchers that had been moved out of the trauma bays in the ED to make room for chairs for fatigued runners were reinstalled and, with the help of admissions staff, the ED patients were relocated rapidly to inpatient floors. "This ED purge-to-surge transfer, which we've drilled on repeatedly, happened very quickly," said Femino.

From the beginning of the emergency activation, security was an issue, and Femino worked with the hospital's security staff and the Boston Police Department to control access to the ED. "We didn't let anyone in the ED—even our own employees—without a pat-down," Femino said. By 5:00 PM, someone from the FBI or Bureau of Alcohol, Tobacco, Firearms and Explosives had interviewed all staff who had had any contact with Marathon patients. These security and law-enforcement activities had been discussed

in tabletop exercises and practiced a little in drills, but they added a large dose of complexity to an already challenging situation.

Despite all those unprecedented challenges occurring simultaneously, Femino witnessed no hysteria or chaos. In fact, one ED physician compared the Marathon bombing aftermath at BIDMC to the scene there on 9/11. “He said there was pandemonium after the 9/11 attacks, even though our hospital didn’t see a single patient from that event,” Femino said. “After the Marathon bombing, things here were quiet and orderly by comparison, because people knew their roles and did their jobs.”

However, as at the Brigham, once word of the bombings spread at BIDMC, hundreds of staffers “self-deployed,” converging in and around the ED. While they intended only to be helpful, “too many people in one area became problematic at one point,” said Femino. On the fly, she and her team staged self-deployed clinicians in a separate area, so they could be deployed as needed, but nonetheless the ED was overcrowded. “We learned that day that the self-deployment of employees in itself should be a trigger for establishing a separate labor pool,” said Femino.

When Michele Mahoney first got to BIDMC, the trauma-team doctors prepared her for the possibility of losing a foot. But when her toe wiggled, and they found a pulse in her foot, they said they might be able to save the foot. “It was like an episode of *ER*,” she recalled. A time stamp on radiographs taken in the BIDMC ED indicated that they were taken less than an hour after the blast. Mahoney explained her stoic and uncomplaining attitude throughout by saying simply, “I knew I was in good hands.”

As he took in the seriousness of the injuries to Ma-

That Could Have Been Us

On Marathon Monday, Beth Israel Deaconess Medical Center trauma surgeon Alok Gupta, MD completed his ICU rounds and paperwork in the morning. He had no surgeries scheduled, so his plan was to grab some lunch and pick up his 3-month-old daughter at home and watch afternoon runners cross the Boston Marathon finish line.

“But she was sleeping when I got home,” Gupta recalled, “and I abided by the adage never to wake a sleeping baby.” Soon after she woke up and he started packing for the finish-line outing, he got the emergency page about the bombing. “My daughter and I could have been 2 of the victims,” he realized as he rushed back to the hospital.

honey and others, BIDMC’s vice chair for ED operations, Leon Sanchez, MD, told the trauma teams to stay in the rooms with their assigned patients, and that he’d make sure they received whatever equipment, resources, or supplies they needed. Femino referred to this as “small zoning,” and it was implemented to protect clinicians from the trauma of seeing more than 1 badly injured patient. “Many of the residents in the ED that day had never seen mass-casualty or war-zone injuries before,” said Femino.

At Massachusetts General Hospital

Massachusetts General Hospital (MGH) orthopaedic surgeon David Lhowe was finishing a routine surgical procedure on April 15, 2013 when he heard about the Marathon bombings—and immediately reported to Dr George Velmachos, chief of trauma, emergency surgery, and surgical critical care, to see where he could be of most use.

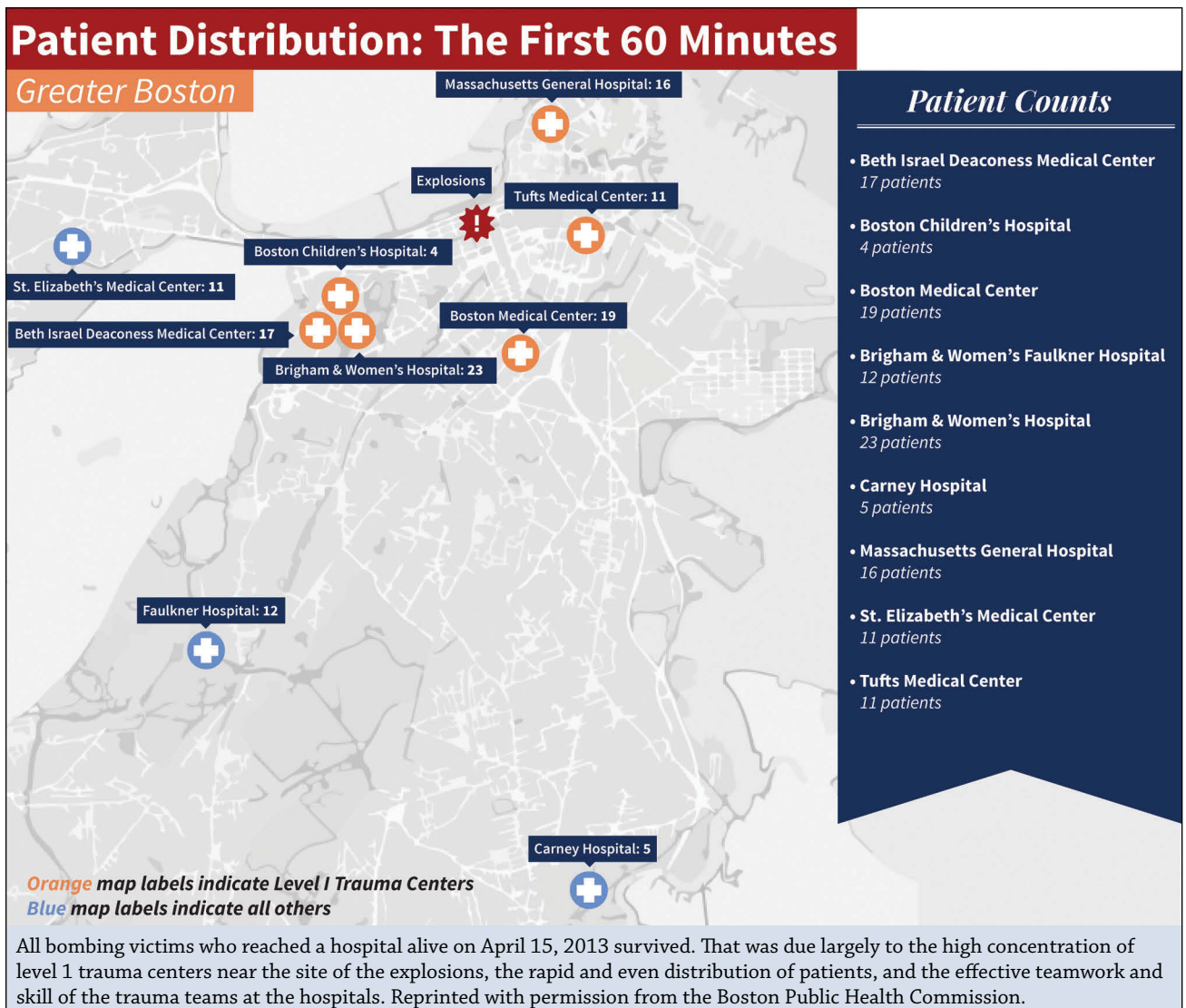
“The first Marathon patient I treated that day ended up with an above-the-knee amputation on one side and a below-the-knee amputation on the other side,” recalled Lhowe. Due to the emergency-preparedness procedures in place at MGH and the willingness and availability of seasoned trauma surgeons such as Lhowe, all the immediate orthopaedic surgeries that had to be done on Marathon patients were completed by midnight.

The fact that neither MGH nor other Boston hospitals treating Marathon patients were overwhelmed that day was due partly to “dumb luck,” according to Lhowe. Like many others interviewed for this special report, he cited the abundance of level 1 trauma centers in the vicinity of the blasts and the timing of the explosions during hospital shift change as fortunate coincidences. “If the bombs had been bigger, placed elsewhere, and exploded at a different time, this could have looked more like Oklahoma City in 1995,” he said. That act of domestic terrorism killed 168 people and injured more than 680.

At Boston Medical Center

The first notification about the bombings came in to Boston Medical Center (BMC) via a phone call to the ED attending physician from a BMC emergency-medicine resident who was staffing the medical tent at the finish line. That was quickly followed by notification from Boston EMS via radio and alerts to BMC’s director of emergency management by pager, phone, and e-mail from COBTH.

Within minutes, a hospital-wide notification was sent and trauma teams formed to receive the injured.



ORs were prepared and staffed, and teams set up a critical-care unit and inpatient floor to receive the patients. “Acuity, not volume, was the defining factor for our response,” said BMC’s director of emergency management, Maureen McMahon. The hospital received 28 patients, 18 triaged as red upon arrival. Sixteen of those underwent surgical procedures within 10 hours of the explosions.

The timing of the event, coincident with the hospital’s shift change, was both a help and hindrance, according to McMahon. “Additional staff afforded a greater pool of personnel to assist with response, but they contributed to issues with crowd control because many self-deployed,” she said. “Except for the overcrowded hallways, it was empow-

ering to witness the whole hospital united in a common purpose.”

At Tufts Medical Center

As soon as word of the explosions came into the command post at Tufts Medical Center, a member of the hospital incident command system (HICS) team asked emergency management director Rob Osgood if this was another one of his drills. It wasn’t, of course, but all that previous drilling resulted in an immediate huddle of the command-post leadership team and a hospital-wide disaster page that brought the HICS team to the emergency operations center.

“Coming out of the huddle, our first request of the

staff was to call home and let their loved ones know they were safe and to check to ensure none of their own family members was affected,” said Osgood. The mutual peace of mind achieved at that early point was essential to helping the staff shift from an expected influx of dehydrated runners to people with blast injuries and coping with the subsequent physical and mental challenges.

About 2 hours after the explosions, as most of the acute patients were already admitted or in the OR, Boston Police ordered an evacuation of the Tufts ED. A suspicious package had been found in the rear of the ED, and an understandably heightened sensitivity to such things (and to what turned out to be an unrelated fire at the JFK Library) forced the police to take no chances and order the evacuation. A dozen ED patients were quickly evacuated to the hospital’s main lobby. “Staff members from all corners of the medical center—physicians, nurses, and support staff—rapidly wheeled equipment, carts, linen, and oxygen tanks out of the ED,” recalled Osgood. “Because of the skills and tactics everyone had learned from prior

exercises, training, and experience, patient care was never interrupted or compromised.”

At Newton-Wellesley Hospital

Meanwhile, about 9 miles from the finish line, with a sea of people running down the street outside Newton-Wellesley Hospital (NWH), one key question was how they would, if necessary, shelter large groups of people in the event of an on-course emergency. When officials halted the race after the explosions at the finish line, a few runners took advantage of the respite area set up in the hospital lobby, where staff were ready with food, drink, and foil blankets.

Out-of-town hospitals responded to the bombings in another indirect but crucial way. Emergency preparedness coordinator Charlotte Roy and her team at NWH used the WebEOC system to learn that Boston ORs needed amputation kits. “The WebEOC helped all the suburban hospitals move assets into Boston as needed,” said Roy.

Chapter 7

Communication During the Week of April 15

The situation in the minutes and hours after the Marathon bombing kept changing, and communicating those changes throughout the emergency-response network was of paramount importance. The incident commanders on the scene, primarily Boston EMS personnel, communicated their awareness of the situation to stakeholders at the MIC. There, COBTH liaison Mary Devine “soaked it up and disseminated it out to the hospitals,” explained MGH’s Paul Biddinger, MD.

Although some hospital emergency officials said they would have liked to know more quickly whether the incoming Marathon patients would have to be decontaminated for chemical or radiation exposure, Biddinger said, “Fire, police, and EMS did a pretty good job of letting us know early that there was no radiation involved, and they did not have reason to suspect hazardous chemicals.”

Overall, Biddinger gives the entire system a B+ grade for communicating situational awareness that day. In the room-for-improvement department, he said, “I think the hospitals, including mine, could have communicated their situational status to the MIC and COBTH liaison a little more quickly, especially in terms of each facility’s security situation.”

For their part, hospitals also needed to report their status to public health authorities, and again Biddinger said this happened “moderately well” after the bombings. Both the Health & Homeland Alert Network and WebEOC were used by hospitals to request needed supplies (such as amputation and vascular kits), and there was quick movement of supplies from outlying hospitals to Boston hospitals.

Rumor Control

As Biddinger explained, COBTH’s Mary Devine was in the

MIC when the bombs went off. She got immediate information from the EMS liaison in the MIC and was on the phone with the Department of Public Health (DPH) Emergency Operations Center almost nonstop for the next few hours. Devine’s 14 member hospitals wanted to know immediately whether the explosion was a dirty bomb—that is, whether the hospitals would be faced with radiation-contaminated patients. They also wanted to know how many patients to expect and when they would arrive.

“Because EMS people were in the MIC with me, I was able to tell hospitals to expect multiple patients per ambulance, and I was able to give the hospitals constant, specific updates from the EMS perspective,” said Devine. Although most Boston hospital EDs have radios tuned to the Boston EMS frequency, the information hospitals received from Devine was more refined and therefore more useful than the raw data coming in on the radio.

At the same time, Devine was providing DPH officials with the up-to-the-minute status reports from each hospital. “At one point, I had 3 land lines working in front of me, along with 2 cell phones,” Devine recalls.

With all the information pouring into the MIC, Devine spent some of her time confirming and dispelling rumors, such as one that there had been bomb threats called into several hospitals after the on-street explosions. Devine got at least 10 phone calls asking for confirmation that the “boom” had been a manhole explosion, a not-uncommon phenomenon in Boston in recent years.

“It took nearly an hour, but I could not say yes or no until I received word from the unified command on the ground that it was a bomb,” Devine said. Although acknowledging that it’s human nature to want to know exact-

“Hospitals need to know the condition of patients coming in to them; they don’t always need to know the details about the source of the disaster.”

Advice From Mary Devine

Because “people will run with whatever you say,” Mary Devine of COBTH has the following advice for a collector and disseminator of disaster information:

- State what you know; do not speculate. If you don’t know something, say so.
- Get definitive answers as quickly as possible and don’t leave any inquiries unanswered.
- Make your responses clear, quick, and truthful.

ly what happened in a disaster, Devine added, “Hospitals need to know the condition of patients coming in to them; they don’t always need to know the details about the source of the disaster.” The COBTH executive director John Erwin concluded, “Information never comes in fast enough, but being right is more important than being first.”

Immediately after the bombings, the Boston Public Health Commission (BPHC) worked with the mayor’s Office of Emergency Management and the Boston Center for Youth and Families to establish multiple drop-in centers, including one at the Park Plaza Hotel’s Castle, near the finish line. “The area around the bombing was a crime scene, and people who lived there or were staying in hotels near there couldn’t get access,” said Atyia Martin, director of the BPHC’s Office of Public Health Preparedness. “Some of those people were runners, and we had to provide basic needs for these people, such as food, shelter, and a place to rest.”

The drop-in centers also reunited runners who had just finished when the bombs went off or who were pulled off the course with their keys, clothes, and other valuables. Per standard procedure, these personal belongings had been transported to the finish-line area, which was accessible after the bombing only to law-enforcement officials.

Thanks to the Office of Public Health Preparedness’ prior networking and the private sector’s generosity, the Seaport Hotel donated space for a full-service family assistance center, where survivors and families of those affected by the bombings could get multiple services in 1 place. Representatives from the FBI’s Victim Assistance unit, the American Red Cross, the State Attorney General’s Office, and the Boston Police Department were on hand there for 10 days straight.

Not only were all those services available in 1 place, families could also access them by filling out a single intake form and confidentiality agreement. “We knew the last

thing these people needed was to confront a bureaucracy with tons of paperwork,” Martin said.

Martin credits the Seaport with not only providing the space but also for providing food for all the families and for allowing access to parts of the building that were not used for the assistance center to ensure accessibility to the assistance center for those with limited mobility.

Patient-Tracking Challenges

Another huge communication challenge posed by the bombing was identifying who was hurt, keeping track of them once they were hospitalized, and reuniting worried loved ones with their injured family members.

All registered Marathon runners carry a chip in their bibs, so that officials can find out whether they are in a medical tent or on the course. These chips also enable families of the runners to track their progress. But the bib-tracking system wasn’t much use after the bombings, because most of the injuries—and all of the serious ones—occurred among spectators.

After the explosions, saving lives sometimes trumped normal protocols for patient identification and tracking. Lots of people and entities, including foreign embassies with citizens running in the Marathon, flooded the hospitals and other agencies with requests to locate specific individuals who might have been injured.

In addition, requests for information from the media and law-enforcement agencies continued to pour in to the MIC and DPH for days after the bombing. Said DPH emergency preparedness director Mary Clark, “We’d given a lot of prior thought to patient identification and tracking in terms of family unification, but not too much in terms of helping law-enforcement officials gather evidence about a crime.”

HIPAA provides an exception to privacy rules that allows hospitals to release patient information to public health authorities to facilitate family reunification after an event such as the Marathon bombings. Guidance is less clear on release of patient information by hospitals in the days after an event for purposes other than family reunification. The Office of Civil Rights in the US Department of Health and Human Services is reviewing and updating existing guidance, and DPH is now working on guidance to hospitals regarding postdisaster release of patient information, including a protocol to centralize collection of that information through DPH for events affecting multiple communities. In the future, foreign consulates and other

entities seeking information will have a single point of contact through DPH.

Family unification activities after the bombings were further complicated by the fact that hospitals tasked with saving lives were hard pressed to make clear and unambiguous identifications of all their patients, let alone answer the outside requests for information with which they were inundated. Family members who wanted to know where their loved ones were hospitalized often had to make numerous calls and wait agonizing minutes or hours before getting that information.

“Everyone in the preparedness and response community knows that we need to do this better, and we’ve taken the steps to do so,” said Atyia Martin.

Sheltering in Place

Unlike the level 1 trauma centers in Boston, NWH didn’t see any seriously injured patients on Marathon Monday, just a few self-referred patients presenting with hearing loss and minor lacerations and abrasions. Its biggest challenge came on Friday, April 19, when Governor Deval Patrick issued a shelter-in-place order for Boston and surrounding towns, including Newton. Meanwhile, local, state, and federal law-enforcement teams were homing in on 1 of the alleged bombers, who was believed to be hiding out in nearby Watertown, about 4 miles from the hospital.

“We didn’t exactly know what it meant for a hospital to be in a shelter-in-place status,” said NWH’s emergency preparedness coordinator Charlotte Roy. The switchboard was overwhelmed with calls from staff wondering whether they should report to work, and the hospital’s emergency-messaging system was at the time unable to push out communications to staff in a timely fashion. (It has since been updated.)

The hospital advised discharged patients to stay at the hospital, and it encouraged staff whose shifts had ended to stay as well. “We had to scramble a bit to find places to put these people,” Roy said. “And some vendors weren’t delivering supplies to the hospital because Boston, Cambridge, and some other municipalities were in full lockdown status.” In fact, ambulances heading to 2 Boston hospitals, St Elizabeth’s and Mount Auburn, were diverted to NWH because those facilities were locked down.

“Things were unclear and somewhat conflicting at the beginning of that day, but because the HICS system was in place and we were communicating with the WebEOC, we learned how to cope as the day evolved,” said Roy.

For BIDMC, the Marathon bombing event didn’t end until the second suspect in the attack, Dzhokhar Tsarnaev, left the hospital. His arrival there on Friday, April 19 was signaled by 2 calls Meg Femino received late the night before about a shooting in Cambridge, followed by intense police activity in Watertown and Brookline. Then she received an alert from Boston EMS about the imminent arrival of the first suspect, who was pronounced dead shortly after arrival at the hospital.

Agreeing with her emergency-management counterpart Charlotte Roy from NWH, Femino said that “Friday was more difficult to manage than Monday.” The HICS was reactivated, and key members of the 125-person incident-management team were called into the hospital at about 1:00 AM on Friday morning. The hospital held a 5:00 AM press conference amid swarms of media and law enforcement.

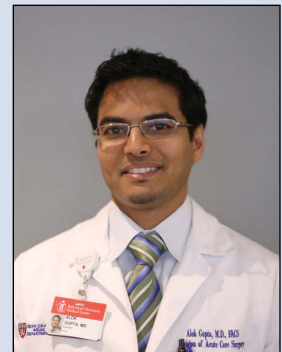
At 5:30 AM, Femino and her colleagues learned that the city’s subway and bus system, fondly known as “the T,” was

Caring for a “Bad Guy”

Everything in a doctor’s training opposes making moral judgments about patients. But what if you’re faced with caring for a person alleged to have caused grave injuries to others already in your care? That’s the situation BIDMC trauma surgeon Alok Gupta found himself in.

“It’s common for me to provide care for a suspected drunk driver in one room and the innocent pedestrian who was hit in the next room,” Gupta said. To further guard against his clinical objectivity being compromised, he purposely didn’t watch or listen to any news broadcasts during the week after the bombings. But he couldn’t help knowing that both suspects in the atrocity spent time at his hospital.

“It’s clear in our minds as doctors that we provide the best care we can for every patient, regardless of circumstances, and put all judgment aside,” Gupta said. He added that confidence that the legal and judicial systems would do their part helped free him from any real moral predicament.



Alok Gupta, MD,
trauma surgeon/
surgical intensivist,
Beth Israel Deaconess
Medical Center

suspending service per order of Governor Patrick and Mayor Tom Menino. That shutdown, in addition to the suspension of the local hospital shuttle service, was, in Femino's words, "hugely problematic." About 40% of BIDMC's 9000 Boston employees take the T to and from work.

However, relatively recent T shutdowns during Superstorm Sandy in 2012 and a blizzard in 2013 had provided some "muscle memory" for dealing with the citywide lockdown. BIDMC got many of its nurse managers in for the 7:00 AM shift that day by providing free onsite parking (an unprecedented perk for anyone working in that area of Boston). BIDMC also asked all staff from the previous overnight shift to stay. "At that point, no one entered the hospital except for emergencies, no one was discharged, and even visitors stayed in place," Femino recalled.

Concerned that the target of the massive manhunt might self-present at the hospital for care, Femino enlisted help from law enforcement to move all vehicles away from the main hospital building and to stop and search all incoming ambulances before they got too close to the hospital. Then, at 10:30 PM, Femino received simultaneous alerts from the MIC and Boston EMS: the second suspect had been captured, seriously wounded, and was on his way to BIDMC.

Clear communications were also important at the Brigham on the Friday after the bombings. No one at the city's hospitals knew precisely what "shelter in place" and "lockdown" meant for their facilities. With public transportation suspended, should patients and employees stay

in the hospital or be sent home? Emergency-management leaders at the Brigham huddled and decided on a strategy, which the public affairs staff communicated across the sprawling main hospital campus and satellite and research facilities.

Similar communication and logistical challenges arose at BMC that Friday. "A significant amount of time and energy was expended to gain information and keep our employees informed," said the hospital's director of emergency management, Maureen McMahon. Exhausted night staff could not go home and day staff could not get in. Meanwhile, the hospital census was climbing, as existing patients could not be discharged to make room for new patients who continued to arrive through the ED.

While staffed around the clock for more than a week, MIC activity subsided a bit after the first 3 days of intensive postbombing coordination. But when the shelter-in-place order and lockdowns occurred, the MIC was buzzing again. "We needed to know which pharmacies in Boston were open and closed, so that any patients discharged from hospitals knew where they could get their medications," Atyia Martin said. Calling from the MIC, Martin and her team got that information from the corporate headquarters of the major pharmacies in 1 hour.

Also, because they were in the same room at the MIC, the DPH and the BPHC worked cooperatively to get a waiver for hospital pharmacies to discharge patients with more doses of medication than standards called for because no one knew how long the city would be locked down.

Chapter 8

Clinician Teamwork

Increasingly, medical care in the United States is a team effort. Intuitively, teamwork should improve the chances for positive patient outcomes and provide an antidote to what has been a fragmented, hyper-specialized system of care delivery. But getting specialists to work together throughout a patient's episode of care is easier said than done, however rational the idea might be. The uniquely tragic and public circumstances under which the Marathon patients were injured prompted the kind of comprehensive clinical teamwork from which all patients could benefit.

Initial treatment of trauma patients is almost by necessity a team affair, and BIDMC is no exception to that rule. But at that hospital, the Marathon bombings led to the creation of a novel “mass-casualty service.”

As a member of the BIDMC disaster committee, acute-care surgeon Alok Gupta, MD was also the surgical department's incident commander during the emergency activation on April 15. Gupta was a medical student in New York at the time of 9/11 and had traveled to Haiti to offer his services after the 2010 earthquake. Both experiences cemented his devotion to trauma and disaster medicine.

A rapidly convened multidisciplinary labor pool of trauma, orthopaedic, and vascular surgeons and surgical residents, along with nurses, physical therapists, and intensivists, enabled each Marathon patient coming in to BIDMC to be assigned a trauma team composed of the most relevant specialties. “But within 3 hours, we realized that this unique set of patients was spread out over the hospital and that the situation had not allowed for normal patient-tracking protocols,” recalled Gupta. “We felt the need to combine what was in our heads with what was in the medical records to compile a list of all the Marathon patients.”

So, late that afternoon, Gupta and his colleagues did just that. The list became the focus of the mass-casualty

service, an ad hoc team of clinicians focused on the Marathon patients, with their similar mechanisms of injury and common clinical needs.

Membership in the mass-casualty service team expanded the next morning when Gupta delivered a status report on the Marathon patients and the hospital's chief operating officer asked him what he needed. “I said I needed at least a physical therapist and social worker for each patient,” Gupta recalled. Thanks to the chief operating officer's intervention, 2 hours later, Gupta was meeting with 30 people representing those and other clinical and nonclinical services, including psychiatry and the acute-pain service. Even otolaryngology and infectious disease were brought onto the service on an ad hoc basis to deal with hearing loss and possible exposures to blood-borne pathogens.

Given these multidisciplinary resources quickly, Gupta established twice-daily patient rounds and twice-daily organizational team meetings to consult on each Marathon patient's needs. During rounds, several patients asked to meet other Marathon patients, so Gupta and the chair of the surgery

department set up a dedicated space where Marathon patients and families could go at appointed times to share, cry, and bond.

Because many of the Marathon patients were facing multiple, staged operations, the new mass-casualty team also arranged for a dedicated mass-casualty OR. “That gave us the ability to decide who should have surgery when, to optimize the patients' clinical needs, and to prevent the various surgical services from competing for OR time,” said Gupta.

The effective teamwork of the multidisciplinary mass-casualty service carried over into a multidisciplinary clinic that Gupta helped establish for Marathon outpatients. “As patients started being discharged, we realized that they would need to see me, an orthopaedist, a plastic surgeon, physical therapist, and often a psychologist or psychiatrist

“These folks and their families had been through too much already to ask them to coordinate 7 or 8 different outpatient appointments.”

What Makes a Disaster-Medicine Doctor?

Dr David Lhowe, orthopaedic trauma surgeon at Massachusetts General Hospital (MGH), has some impressive credentials on his disaster-response resumé. He spent time in a makeshift field hospital next to “the pile” that was the World Trade Center in New York after the 9/11 attacks. In 2004, Lhowe spent a month working with the US Navy on its hospital ship USNS Mercy, helping survivors of the Indonesia earthquake—the deadliest natural disaster in recorded history, with more than 230 000 fatalities. He called these unique opportunities to help “an unbelievable gift.”

Lhowe credits his initial interest in disaster medicine to Dr Susan Briggs, an MGH general surgeon with expertise in international mass-casualty management. She spearheaded the establishment of a disaster medical assistance team, and Lhowe became involved. “Prior to my first deployment in a nonprophylactic situation, we met routinely to work on protocols and equipment lists,” Lhowe said, referring to the more mundane but equally important work of disaster medicine.

Lhowe remains part of Dr Briggs’ team, which has expanded into several International Medical Surgical Response Teams. He was set to deploy again with the Navy to Haiti after the January 2010 earthquake, but a second wave of surgeons was canceled because the Navy completed its mission sooner than expected.

Observing that there’s always a spike in physician interest in disaster medicine following a natural or human-made catastrophe, Lhowe encouraged orthopaedists who are interested in this area to let their hospital’s emergency management leaders know. In addition, he says excellent training is available through the American Academy of Orthopaedic Surgeons and the Orthopaedic Trauma Association.



Aboard the US Naval Hospital Ship Mercy, orthopaedic trauma surgeon David Lhowe, MD (left) attends to a patient injured in the 2004 Indonesian earthquake and tsunami (right). Because it was difficult to arrange follow-up care after these individuals left the ship, surgeons wrote instructions on patients’ casts.

as outpatients,” said Gupta. “These folks and their families had been through too much already to ask them to coordinate 7 or 8 different outpatient appointments.”

During the special outpatient clinic appointments, the Marathon patients stayed in one place and the clinicians came to them. This system enabled most patients to be seen by all their care providers in about an hour. It also facilitated face-to-face, clinician-to-clinician consults, and enabled 1 dressing take-down instead of repeated ones.

Gupta credits BIDMC leadership with making this high level of teamwork possible. “All administrative barriers were lowered with enthusiasm,” he said.

MGH orthopaedic surgeon David Lhowe has a humble take on acute-care teamwork. As an experienced disaster-medicine doctor, he noted that “surgeons are often not in charge during disasters. They are part of a team that defers to the incident command structure.” That means that what’s theoretically medically “correct” has to be weighed with other issues, such as space, equipment, and security. “Often, the surgeon is just another team member in these situations,” Lhowe said.

On the other hand, Lhowe added, surgeons and other team members will always experience some separation from the team effort because “team members have different skills and specialize in doing different things.... But we should always value each other’s contributions.”

Teamwork in Rehab

After their acute-care hospitalizations, many Marathon patients needed inpatient rehabilitative services. Thirty-three of them ended up at Spaulding Rehabilitation Hospital in Charlestown, 15 with amputations.

“In general, everything we do here is based on a team approach,” said Cara Brickley, DPT, program director of Spaulding’s Comprehensive Rehabilitation Unit (CRU). Each patient on the CRU has a case manager who makes sure that the physicians, nurses, and the physical, occupational, and speech therapists are all on the same page regarding the patient’s current status, next steps, and barriers to meeting those plans.

Discharges from any hospital present opportunities for disconnects and miscommunication, and those lapses fre-

Brickley's Bottom Line

- Get everyone's input on problems and solutions. There are more parts to a truly interdisciplinary team than most people imagine.
- Clarify the team's goals and reach consensus on how to achieve them. Don't dictate from the top down.
- Remember that improvements in team-based communication are always possible, especially around discharge planning.
- Don't let the communication challenges that come with interdisciplinary activities deter you from going the interdisciplinary-team route. "It is the best approach to quality patient care," Brickley said.

The Amputee Clinic

One especially noteworthy aspect of team-based care at Spaulding occurs every Wednesday morning, when David Crandell, MD convenes team clinics for limb-loss patients. The clinic brings together the patient—the most important part of the team—physiatrists, physical therapists, the patient's prosthetist, often the patient's family, and occasionally a psychologist. "These are the 3 hours of my week that are truly interdisciplinary," said Crandell.

The clinic room has an examination table, parallel bars, and a mirror, so various functional tests can be performed. "This is the truest form of rehab because it includes the patient in real-time evaluations of function and consensus decision making," said Crandell.

In the amputee clinic setting, said physiatry resident Jennifer Earle, MD, Crandell does not dictate but rather collaborates. She calls these clinics "think tanks, where there's room for creativity and bouncing ideas off one another."

A number of prosthetists, including Arthur Graham from Next Step Bionics and Prosthetics, have participated in these interdisciplinary team clinics. "Any time you can have all the heads in the same room for the benefit of the patient, it's a good thing," Graham said. Such group conversations about socket design, component choice, and muscle contractures helped him with his Marathon patients.

quently result in unnecessary rehospitalizations. "We're very careful about services and referrals that need to be in place prior to discharge," Brickley said. Each patient leaves Spaulding with evaluations from all clinical services, including behavioral health, and specific recommendations for future

care are sent to the home health agencies, physical therapists, and other clinicians who might engage with that patient.

But comprehensive teamwork was also the name of the game during the Marathon patients' stays at Spaulding.

Physiatrist David Crandell, MD is medical director of Spaulding's Amputee Program. He's quick to emphasize that teamwork was involved in helping Marathon patients from the outset. The collaboration between surgeons and physical medicine and rehab specialists (physiatrists) is a case in point. Nowadays, electronic medical records help facilitate communication between surgeons and physiatrists regarding the nature of the surgeries and recommendations for rehab. But as Marathon patients were being discharged, "surgeons were calling me on the phone about multiple patients they were sending us," said Crandell.



David Crandell, MD, director, Amputee Program, Spaulding Rehabilitation Hospital

Behavioral Teamwork

Although members of the mental health team are not typically in on the interdisciplinary case-review meetings at Spaulding, they did attend those relating to the Marathon patients. This gave everyone on the care team a chance to stay current on everyone's physical and emotional status. The fact that all the Marathon patients were clustered in 1 unit facilitated multidisciplinary collaboration. "Real-time communication about patients is better than relying on paper or electronic documentation because it enables rapid problem solving," observed Chris Carter, PsyD, a member of Spaulding's Department of Behavioral and Mental Health.

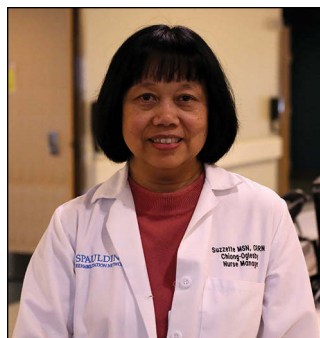
Perhaps even more importantly, mental health staff—which included psychologists, psychiatrists, and social workers—were constantly on the floor and in the patient rooms, giving survivors and their families opportunities to process emotions spontaneously and watching for signs of stress in the staff.

They also did some impromptu training in supportive listening for the nurses, physical therapists, and occupational therapists. Just by doing their jobs, these hands-on caregivers were confronting the Marathon patients with the

reality of their disabilities, and Carter knew those interactions would in many cases trigger “emotional content” for which he wanted the non-mental health staff to be better prepared. Listening to the patients talk about their experiences with the bombing and with their recovery was going to be emotionally challenging for those taking care of the patients. Staff were looking for guidance as to the most appropriate ways to respond.

Carter was especially impressed by how the overnight-shift nurses responded effectively and compassionately to the letdown of emotional defenses that often occurred among patients in the nighttime quiet. “The work of repair and healing—both emotional and physical—took place around the clock,” Carter said, “and it was not limited to any single discipline.”

At Spaulding, coordinating nursing schedules—such as dressing changes and medication administration—with rehabilitation therapy schedules is standard procedure. “Nurses talk to physical therapists about when is the best time to do a dressing change relative to the PT schedule,”



Suzette Chiong-Oglesby, RN, clinical nurse manager, Spaulding Rehabilitation Hospital

said clinical nurse manager Suzette Chiong-Oglesby, RN. “We do our best to schedule the patient’s day so that therapy doesn’t interfere with nursing care, and vice versa.”

Echoing other clinicians at Spaulding, physical medicine and rehabilitation resident Jennifer Earle, MD said, “The interdisciplinary team approach is the cornerstone of what

we do here.” During the twice-weekly patient reviews with psychiatry, physical therapy, occupational therapy, nursing, and the case manager, team members brainstorm about how patients will meet their next goal, and what they’ll need to make a smooth and safe transition back into the community. “The community outings, where patients can practice ambulating in their own neighborhood, dining at a restaurant, or taking public transportation, require a high level of multidisciplinary coordination,” said Earle.

Some Marathon patients were discharged directly home from the acute-care setting, bypassing inpatient rehab. That was the case with Kaitlynn Cates. But that didn’t stop Cates’ surgeon, David Lhowe, from being very in-

involved with Cates’ physical therapy, which began at home. “Because there was no mechanical instability in her leg, there weren’t many restrictions once the wound healed, so I favored stepping up the level of activity pretty early on,” said Lhowe. And he got no resistance about that from Cates or from Dave Nolan, her outpatient physical therapist.

In challenging cases, Lhowe prefers direct e-mail or phone contact with physical therapists who have specific questions, rather than relying on computer-generated notes or medical records. “A lot of the paperwork generated is extraneous and more designed to meet regulations than communicate,” opined Lhowe. “So I appreciate when a PT contacts me by e-mail or phone with a question or concern. It makes sense to communicate directly with the people who do the work I prescribe.” This “offline” communication also helps raise flags on occasionally conflicting self-reports. “Patients don’t always tell their surgeon and PT the same thing about their progress and physical capabilities,” Lhowe observed.



David Lhowe, MD, orthopaedic trauma surgeon, Massachusetts General Hospital

Patient Perspectives

Michele Mahoney didn’t realize it at the time, but as soon as she arrived at BIDMC, she was assigned an interdisciplinary team of clinicians. Throughout, Mahoney noted how all the clinicians “educated me and encouraged me.” She also appreciated the fact that she and the other Marathon patients had a 1:1 nursing ratio. One of those nurses cleaned Mahoney’s fingernails prior to her second surgery and brought her nail polish for use after the operation.

From Mahoney’s perspective, the only hiccup in the acute-care hospital occurred when doctors did not diagnose the Achilles tear right away. “At first, it was all about saving the foot,” said Michele, understandingly. The Achilles rupture was discovered after her first surgery during a tertiary survey and was repaired during a later skin-graft procedure.

While the teamwork and compassion at Spaulding were also exemplary, Mahoney got the sense that some of the nurses had never seen wounds and skin grafts quite as extensive as those she and some other Marathon patients

presented with. At one point, she was waiting for a nurse experienced with deep wound care, with her leg undressed. “I broke down then,” recalled Mahoney. “I wasn’t used to seeing my leg in that condition and I couldn’t picture it ever being healed.” But the interdisciplinary team at Spaulding also facilitated visits from wounded military personnel. One who’d had several skin grafts visited Mahoney, “That made me more confident that my legs would heal someday,” she said.

Calling her physical therapy experience at Spaulding outstanding, Mahoney even got the chance to take a canoe outing on the Mystic River. Team members from Spaulding’s Adaptive Sports Program and Mahoney’s other clinicians knew how active she was before the bombing, so they wrapped her air-casted limbs in large trash bags and accompanied her into a specially designed canoe (see photo below) for a paddle in the May sunshine.

Say what you will about the large, integrated health care delivery systems that are forming throughout the country, but they do provide the hope of more coordinated care and effective interprovider communication—as long as the patient stays inside the system.

Partners HealthCare is the largest such system in Massachusetts. Kaitlynn Cates, who suffered a severe deep-tissue shrapnel wound to her gastrocnemius muscle that required 4 surgeries to treat, described the collaboration between David Lhowe, her orthopaedic surgeon at MGH and other Partners-affiliated providers as “phenomenal.”

When Cates went to see a plastic surgeon to discuss a procedure to improve the contour and function of a 6 × 3-inch skin graft, she recalled, “He knew more about my previous surgeries than I did.” That’s largely because Lhowe talked with Cates about her goals for this surgery,

was thorough in his research of possible referrals, made detailed notes in Partners’ electronic health record system, and spoke with the plastic surgeon in advance.

An equally smooth transition for Cates occurred when Lhowe handed off her care to Partners-affiliated physical therapist Dave Nolan, DPT, who is a clinical specialist at MGH Sports Physical Therapy and who was also the physical therapy “captain” in the finish-line medical tent at the time of the Marathon bombings.

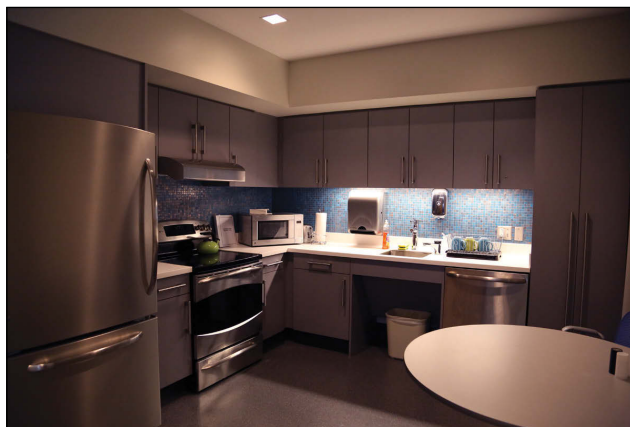
Nolan and Lhowe have never met face to face, but understanding and trust have grown between them thanks to their individual dedication, Partners’ integrated electronic health record and e-mail systems, and that old technology known as the telephone, all of which allowed them to discuss the details of Cates’ case. “I’ve seen several of Dr Lhowe’s patients over the years, and it’s easy to get and stay on the same page with him,” said Nolan. This back-and-forth communication helps Nolan know when he can safely progress Cates’ therapy to the next level.

Marathon patient Roseann Sdoia also considers herself fortunate because, like Cates, she was brought to MGH and stayed within the Partners system as an inpatient at Spaulding Rehab. “The verbal and electronic communication was excellent,” Sdoia said. “Everyone has access to centralized information, so they know what the right and left hands are doing. It can get very confusing if your care happens in different systems.”

Sdoia’s physiatrist at Spaulding, David Crandell, communicated often and clearly with her surgeon, David King, who, after completing the Boston Marathon before the bombing, ran to MGH to start caring for patients. She also



The Adaptive Sports Program at Spaulding Rehabilitation Hospital uses outrigger canoes designed to help patients rebuild strength and a sense of independence.



Occupational and physical therapists at Spaulding Rehabilitation Hospital help people with disabilities practice getting around the kitchen with this full-scale model.

appreciated the training she received from physical and occupational therapists in the mock kitchen and bathroom setups at Spaulding (see photo on page 33).

Managing the Media

The media always swarm around disasters. It's their job to satisfy the concern and curiosity of information-hungry consumers. Still, some of the health care providers who treated the Marathon patients were not entirely prepared for all the lights, cameras, microphones, and people that accompanied the media's investigation into the bombing and its survivors.

Due to the very tight security and at-times overwhelming law-enforcement presence in the acute-care hospitals after the bombings, the news crews couldn't get a good foothold inside those premises. But the brand-new Spaulding Rehabilitation Hospital presented a much better venue for exploring the many angles of a story that came to acquire the tagline "Boston Strong."

The staff at Spaulding got a taste of what media attention would look like just days before the 2013 Marathon,



Cara Brickley, DPT,
director, Comprehensive
Rehabilitation Program,
Spaulding Rehabilitation
Hospital

as they were preparing to move from their old building to a new, state-of-the-art facility in Charlestown. That was news in itself, as it would be the first new hospital to open in the Boston area for many years, and the media were ready to cover it. "But we had no idea what was coming next," said Spaulding's Cara Brickley. When Marathon survivors started arriving at the old Spaulding facility, the media were already focusing on them there.

"Media circus" is a cliché to describe the numerous distractions newsgathering can impose on any situation. But it's an apt description when the media enter a hospital setting, where everyone's full concentration is usually on delivering patient care.

It became clear quickly to Spaulding administrators that managing the media would be necessary to allow doctors, nurses, and therapists to do their jobs. So they formed an ad hoc task force of administrative, communications,

and clinical personnel to manage media requests for interviews and access.

The co-location of all the Marathon patients on 1 floor made it easier to enact access restrictions, and a dedicated conference room was set up for press conferences and patient interviews, so patient rooms were maintained as sanctuaries. Anyone desiring access to the CRU had to be cleared first and buzzed in through a secure entrance. Marathon patients received aliases to protect them from the few visitors who showed up more for their own benefit than for the sake of the patients.

Although he had to say no to a few media requests, Crandell tried to be gracious with the media. "I saw their presence as a chance to educate people about what we do," he said. "And the buffer created by the task force enabled me to focus on being a doctor."

Brickley credited Spaulding communications director Tim Sullivan, who was a key member of the media-management task force. "Tim let all the clinicians know who had been cleared to come in and speak to which patients at which time," she recalled. The bottom line for Brickley: "We did not let the media interrupt anyone's treatment schedule.... Any media visits were scheduled to occur around scheduled treatments." Clinical nurse manager Suzette Chiong-Oglesby appreciated those boundaries. "It was imperative that the media worked around our schedule, not us working around theirs," she said.

Because of the media crush during the day, the evening- and overnight-shift nurses got to know patients in a different way than the day-shift nurses did. The off-hours were when some of the most difficult patient emotions surfaced. "In some cases, it was as if these were different patients at night than during the day," said Chiong-Oglesby.

Just as any group of individuals might, the Marathon patients had variable responses to the media presence in their midst. Once the onslaught began, Michele Mahoney and her family decided to stay out of the limelight. "I wanted to concentrate on my recovery, my family, and my friends," she explained. "I felt at times like my room at Spaulding was the only one without TV cameras in it all the time."

On the other hand, for Roseann Sdoia, doing interviews was therapeutic. "Talking about it, even to people I don't know, helped a lot," she said. Concluded psychiatry resident Jennifer Earle, "We helped facilitate for those patients who wanted to interact with the media and protected those who didn't. The media attention eventually eased up, but the rehab for some of these people will not."

Chapter 9

Emotional Support

Multiple studies have found that the emotional health of patients influences outcomes of surgery and rehabilitation. For Marathon patients and their families—and for their care providers—emotional support came from multiple sources.

Michele Mahoney was one of the few people standing very close to the bombs who either didn't die or lose a limb. This triggered a lingering ambivalence. "At first, I was happy just to be alive and have both my legs," said Mahoney. "Then, there were up and down days."

Mahoney was in the best physical shape of her life when she was injured. As she lay in bed in the hospital and in rehab, she couldn't help thinking about how all that fitness had been wiped away in a second. Mahoney now sees her life as divided between "old" and "new." She's not overly anxious that another bombing will occur, but she said, "I'm cognizant how easy it would be for someone to do it.... It's changed the way I think about some things."

Although Mahoney saw some people with amputations and brand-new prosthetics leave rehab before she did, "I felt it was a gift to have both my legs, even if in the short term, recovery was harder and filled with restrictions," she said.

At times during rehab, she felt downright guilty about still having legs, considering that one of her closest friends lost both of his in the explosion. At other times, she said to herself, "I didn't lose my legs, but I have to live with *these* legs for the rest of my life." And Mahoney admits that grappling with the uncertainty of her recovery was occasionally difficult. She felt anxiety about questions such as when she'd be able to move back into her Boston apartment and return to work.

As motivated as she was to get back to her apartment and her job, Mahoney said the "Boston Strong" slogan that arose from the incident can be hard to live up to. "I think

it puts a lot of pressure on survivors to always be strong," she said, "and that is just not possible."

Roseann Sdoia had an above-the-knee amputation as a result of the bombings, but she said she harbors neither anger about the situation nor hatred toward the perpetrators. She also didn't see much of the carnage after being hurt,

so she doesn't experience the flashbacks and nightmares that some survivors do. Sdoia received emotional support while an inpatient at Spaulding and sought some

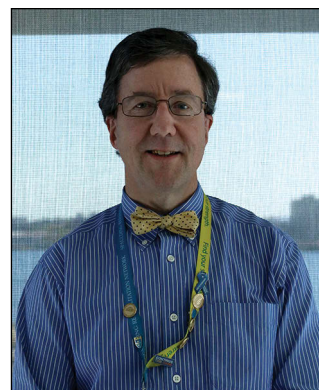
additional therapy after discharge. "There are days when I say, I hate this—I'm done," she said. "But there's the next day around the corner, and I believe everything happens for a reason."

Everyone who arrived at Spaulding for rehab following the Boston Marathon bombing was screened for emotional health issues. "Given the situation, we didn't want to wait to see if any problems developed," said Spaulding's Chris Carter, PsyD.

Carter and the other members of the mental health team interviewed each Marathon patient the day they arrived and, whenever possible, received intake briefings from each patient's family as to patients' coping styles and pre-event activity levels and interests. Social workers had separate interviews with family members to provide support and to ascertain their psychosocial needs.

There may have been some redundancies, Carter concedes, "but we were not concerned about overdosing these people with mental health resources," he said. From a psy-

"I felt it was a gift to have both my legs, even if in the short term, recovery was harder and filled with restrictions."



Chris Carter, PsyD,
director of behavior
medicine, Spaulding
Rehabilitation Hospital

chological standpoint, the key during these early days at Spaulding was to dampen anxiety and minimize emotional arousal so the rest of the rehab program could begin.

Within a week, Carter and his team started receiving requests for a group meeting among Marathon patients. Arrangements were made, and the group, open to any Marathon inpatient and facilitated by Carter and another clinical psychologist, met weekly 6 times.

During the first couple of meetings, patients compared notes about where they were when the explosions occurred and their reactions to the blasts. Some reported mentally preparing to die, while others could think only of where their friends or family members were. Carter recalls having to “dampen down” the graphic accounts of 1 or 2 patients, lest the details prove to be too emotionally overwhelming for other group members.

Three weeks into the group meetings, many participants began to shift away from processing the trauma to expressing anger toward the perpetrators. Some characterized the bombers as evil. But those emotions were balanced by a steady stream of support—within the group and from without. “By then, we were getting donations, gifts, and visits from injured military veterans, sports heroes, and movie stars,” Carter recalls. “Participants began to cite these donations and the messages of support and encouragement as confirmation that there is good throughout the world to counter the evil of terrorists.”

When members of the Washington, DC-based Semper Fi Foundation visited the unit, Carter sensed a turning point in attitude. “You could see people saying to themselves, ‘Maybe I can do this,’” he said. “These visits, along with visits from other amputees living successful and productive lives, were a critical source of hope and inspiration for our patients. Seeing others who were severely injured walking and conducting themselves with confidence gave them hope that they too could return to the important parts of their lives.”

Carter said the meetings were easy to run; his main jobs were ensuring that everyone who wanted to had a chance to speak and de-emphasizing graphic details if there were signs anyone was being retraumatized. His biggest challenge as facilitator was the shifting membership and consequent changing emotional constitution of the group, as some members were discharged and new patients

arrived. Some of the later arrivals had more complicated medical conditions that had required multiple surgeries and lengthier acute-care hospitalizations. Not surprisingly, their emotional needs were different from those of the early group members. Still, he noted a consistent willingness on the part of the “old hands” to warmly welcome newcomers.

Another challenge Carter and his team faced was the constant awareness that there were other patients in the CRU who weren’t getting quite this same level of outside attention. “Every day, we help people who have experienced traumatic loss, who face multiple surgeries, who have limited financial resources—those same challenges faced by many of the bombing patients,” said Carter. “We had to fit in our extra work with the Marathon patients without in any way shortchanging anyone else.”

After about 6 weeks, the inpatient support group disbanded. “People were all talked out and were ready to move past the trauma of the bombing to start focusing on the challenge of recovering from their injuries,” Carter said. To accommodate those who wanted or needed more group support following discharge, Carter’s team worked with

in-house social workers and mental health providers in the community to establish outpatient groups.

For those in non-mental health medical specialties,

measuring the efficacy of mental health interventions may seem more squishy than measuring the efficacy of a surgical technique or medication. Carter and his team gauged the efficacy of their inpatient work at Spaulding with measures such as refusals to participate in physical therapy. “For the mental health team, the primary goal with inpatients is to make sure they’re engaged with their rehab,” he explained. “If people are refusing care or therapy, we want to find out why, because emotional reasons often come into play.”

Caring for the Caregivers

Events like the Marathon bombing can have a tremendous emotional impact on any care provider—physicians, nurses, imaging techs, registration and administrative personnel, transporters, and housekeeping staff. “The solution,” said the Brigham’s Ron Walls, “is *not* to tell people to ‘suck it up.’”

At the Brigham, early responses to caregiver emotions on the day of the bombings occurred during group debriefings called “hotwashes.” The term comes from the Army’s practice of hotwashing weapons, giving them a quick

“What helps most is seeing people get better, seeing something good come out of all that tragedy.”

cleaning that can save time and prevent malfunctions later. “We got our staff out of the unit as soon as possible after the dust had settled a bit and met in a break room,” Walls explained. “A senior preparedness leader monitored the sessions and did a quick introduction, but then we just let everyone talk about what they observed or experienced and what they were worried about or afraid of.”

There were multiple hotwashes over several days at the Brigham, and over the next couple of weeks the hospital’s employee health services department called every staffer by phone who had direct contact with the disaster to offer further support. “This was a good way of identifying people who needed additional services,” said Walls.

Always touting the advantages of preparedness, Walls claimed, “Readiness improves the emotional framework for all caregivers. We conducted a lot of after-event sessions to help those who might be traumatized, but it was the work we did beforehand that was most important. Those extensive trainings and drills gave people the confidence to cope in the face of an enormous challenge, and the fact that they did such a great job for the Marathon patients reinforces our whole preparedness strategy.”

Over at BMC, “the Marathon bombings affected all our employees to varying degrees,” said Maureen McMahon, “some via direct interaction with patients, some vicariously through colleagues, and some because they felt helpless.”

To ensure the emotional well-being of its staff, BMC initiated a “campaign of healing” that acknowledged the pain but celebrated the resiliency of the teams. Activities have included the creation of video clips of employee experiences, employee-recognition activities, milestone memorials, team presentations, and hospital-pride activities.

Many Spaulding Rehab employees ran in the Marathon to raise funds for the hospital and saw or heard the bombs detonate. Many other Spaulding-ites were spectators in a viewing area near the finish line when the second bomb went off and were forced by law-enforcement and public safety officials to evacuate the scene. A few were volunteering in the medical tents and saw the most grievously injured rushed into ambulances.

Carter himself was at the old Spaulding location when the explosions took place—and he ended up staying there late into the night, talking with several fellow employees who were shaken by the day’s events. Some were feeling guilty about following evacuation orders when they “should have stayed.” Others were terribly

traumatized by witnessing the event and needed time to vent. Carter met with a number of employees and runners who’d had direct exposure to the event, doing 30- to 60-minute debriefs with each and subsequent check-ins over the next 2 weeks.

For himself and his colleagues, “Being part of the healing process was comforting for many of us,” Carter said. “What helps most is seeing people get better, seeing something good come out of all that tragedy.”

For physiatry resident Jennifer Earle, MD, seeing family reunions among Marathon patients at Spaulding was almost as gratifying as helping people get back on their feet. “Members of the same family sometimes ended up at different acute-care hospitals after the bombing,” explained Earle. “For some of those, the first time seeing each other again was here at rehab.”



Jennifer Earle, MD, resident in physical medicine, Spaulding Rehabilitation Hospital

Suzzette Chiong-Oglesby appreciated that Carter and his team were on the floor and ready to listen to her and her staff. Chiong-Oglesby’s son, running the Marathon that day as part of the Spaulding team, was about a mile away from the finish line when the blasts occurred and he was prevented from finishing the race. Relieved that her son avoided physical injury, Chiong-Oglesby still had to deal with his anger and disillusionment about not finishing a race for which he had prepared long and hard. Plus, as a spectator near the finish line, she herself had seen and heard the second explosion. “Dr Carter encouraged me to talk all this through with him, and he and the other members of the mental health team did the same for the entire nursing staff,” she said.

Community Mental Health

While a dedicated contingent of mental health providers was concentrating on the emotional health of individual survivors and caregivers, public health officials in Boston and the state DPH were looking at the postbombing emotional well-being of residents in Boston and the surrounding communities.

Delivering mental health services—and apprising the public of the availability of those services—was a huge part of the work coordinated by BPHC and DPH staff in the MIC after the bombing. The BPHC and DPH worked with the US Department of Health and Human Services and the state Department of Mental Health to provide local, state, and federal mental health resources. Nongovernmental agencies such as the Salvation Army and the American Red Cross also helped out.

“We had a lot of people needing support,” Atyia Martin recalled. Many requests came from hospitals whose employee-assistance programs were overwhelmed, and this local-state-federal coalition of mental health services also provided help to volunteers and employees of the Boston Athletic Association, organizers of the Marathon, and to ambulance personnel who transported the injured.

In the weeks after the Marathon and before the Fourth of July—another planned mass-casualty event in Massachusetts—the DPH and BPHC continued informing groups impacted by the Marathon bombing about available mental health resources.

As director of child, adolescent, and family health for the BPHC, Deborah Allen, ScD is no stranger to helping individuals and families who’ve been traumatized by community violence. But when she was thrust into the role of coordinating mental health services for an entire community after the Marathon bombings, Allen said that “despite a constant mindset of trauma intervention, I had no prior experience dealing with something of this magnitude. The enormity of the mental health demand—and the variety of needs—was a revelation to me.”

Thankfully, between people she had on her staff and close connections with many trauma-trained clinicians in the community, she had a cadre of professionals to call on for help. Also, because the MIC was in full operation when Allen’s expertise was tapped, she was able to get in touch with mental health leaders from relevant state and federal agencies.

Allen quickly realized that broader community mental health interventions would be needed for people beyond those most physically affected. Coordinating those requests for assistance—from local churches and even from Martin Richard’s Little League team (8-year-old Richard

was one of 3 people killed in the attack)—was challenging, but she made sure clinicians showed up wherever they were asked to.

Although many of the first-responder organizations provided mental health services to their employees and volunteers after the event, Allen said, “We made sure we had mental health services available for those people, also, especially during the postbombing events, such as the reopening of Boylston Street, when they were on duty and might want someone to talk to.”

The notion of creating community support groups emerged as Marathon patients were leaving hospitals and rehab and expressing a need for such meetings. The community-based support groups started as 2 separate entities—1 for people very physically affected, including amputees, and 1 for those not as affected. The groups merged into 1 quickly, because patients in the former group had so many conflicts with medical and physical therapy appointments. “We ended up with 1 group comprised of people with a range of injuries,” said Allen.

The meetings were organized by Donna Ruscavage, LICSW, the BPHC’s full-time victim support specialist, and facilitated by Al Baptista, a mental health clinician specializing in trauma.

“There’s a very real sense that this group is a second family for the people who attend.”

Allen said support groups of this sort typically have an end date because participants want to be weaned back to their day-to-day lives and not see themselves as permanent victims. “But we’ll keep this group going for as long as people need it,” she said.

The weekly support group for Marathon patients and families was designed as a drop-in meeting, while similar support groups (for coping with a disease or loss of spouse, for example) often expect an attendance commitment. “We wanted to make it as convenient and accessible as possible,” said Ruscavage. “We encouraged people to come every time, but we wanted them to feel free to come when they wanted and needed to.”

Each group meeting lasts an hour and 45 minutes. At the beginning, Ruscavage shares updates and community news of interest and reminds group members about available resources. Whenever a newcomer arrives, facilitator Baptista delivers some basic psychoeducation about how trauma affects the brain and how posttraumatic stress disorder is diagnosed and treated.

Then, there's an open how-are-you-doing discussion. "Early on, the open discussions focused on the trauma of being there and how the event changed them," said Ruscavage. "Later, people talked about their fears of being in crowds, of hearing loud noises and sirens." Much of the talk is about triggers that bring people back to the memory of that day. Baptista teaches participants mindfulness exercises they can use to return them to the present moment when a trigger occurs. The last 15 minutes are devoted to a closing exercise, usually either a round-robin discussion about what the previous hour brought up emotionally or a relaxation exercise to emphasize in-the-moment strategies for coping with anxiety.

Occasionally, a guest speaker joins the group. Ruscavage recalled one meaningful visit from a Semper Fi Foundation amputee and his service dog and educational sessions from yoga and art-therapy instructors from the Trauma Center at the Justice Resource Institute.

Ruscavage also makes referrals for short- or long-term therapy for group members. For that, she relies on an extensive list of individual, couples, and family counselors in Boston and surrounding cities and towns.

"There's a very real sense that this group is a second family for the people who attend," said Ruscavage. "The strength from the common-bond connection is palpable and gratifying to see."

Caregiver-Patient Bonding

It is natural, perhaps instinctive, for people who are seriously sick or injured, vulnerable, and in need to connect in a deep way with those who care for them. But the bonds that have formed between survivors of the Boston Marathon bombings and their first and second responders, their surgeons and nurses, and their physical therapists are uniquely strong—and bound to last a lifetime.

Kaitlynn Cates' relationship with her at-home physical therapist left something to be desired. As can be true of some health care providers, regardless of specialty, the person was skilled but not very sensitive. "I wasn't sure she even knew how I'd been injured," recalled Cates. If Cates was worried that her outpatient physical therapist would display the same type of clinical coldness, she needn't have been. When she went to her first visit with David Nolan, DPT about 8 weeks after the bombing, she wasn't aware that Nolan was at ground zero right after the bombs went off. He was one of those first responders, performing wound compressions, applying tourniquets,



Marathon patient Kaitlynn Cates and her physical therapist Dave Nolan, DPT.

and getting people on stretchers and backboards to be transported.

Nolan didn't reveal any of that to Cates until the end of her first visit, but he said, "I knew a lot of what happened without her having to explain it. Her medical history took itself."

When Nolan revealed that he had been there that day, Cates started crying. Some of the tears were from relief. "Dave and I don't need to talk about [the bombing] because we were both there," Cates said. "We are on the same page without having to discuss the details."

Nolan has built strong relationships with patients before, but this one is unique. "This bond happened quickly and it is based on something horrible," he said. "There's an unspoken understanding of the emotional piece that helps me treat Kait's physical challenges. I always try to treat the whole patient, rather than just a list of impairments, but the connection with Kaitlynn through the event makes that impossible not to do."

"And she has helped treat me," continued Nolan. "A siren, Fourth of July fireworks, or my 2-year-old daughter crying can bring me back to that day. Kaitlynn and I can talk about that kind of stuff, and it helps me."

Kaitlynn has received emotional support from other sources as well. She sees a trauma counselor one on one, and she makes occasional appointments with her surgeon, David Lhowe, even though she's been officially discharged as a surgical patient. "I find talking to Dr Lhowe very com-

forting,” Cates said. “From the beginning, amid the chaos, he explained everything to me and was very optimistic.”

Dr Lhowe performed surgery on Cates the day after the bombings. When told how much Kaitlynn appreciated his clear and calm explanations of her surgical plan, and what would happen after, he simply said, “It’s important to explain things to patients, and it doesn’t necessarily take a lot of time.”

Inherent empathy and years of experience as a disaster-medicine doctor have proven to Lhowe that the most effective explanations are those that take into account the situation and the patient’s ability to understand and concentrate. “In emergencies, it’s often hard for patients to concentrate, so then I try to simplify to the best of my ability, lay out the main points of consideration or concern, and continue the conversation later,” he said.

During postdischarge appointments with Lhowe, Cates brings him up to date on her rehab, and Lhowe helped her recently with decision making regarding plastic surgery and a referral. In addition to helping Cates navigate clinical intricacies of her ongoing care, Lhowe simply lends a sympathetic ear. “If I have the time to talk and if talking helps her, that’s great,” he said. Lhowe believes that pretty much everyone directly exposed to the Marathon trauma will have emotional ups and downs, and that those who seemed unaffected early on may develop problems later.

Spaulding’s Suzzette Chiong-Oglesby has 2 top concerns: first and foremost is making sure that the individual patients receive the best possible care, but coming in a close second is the efficient use of nursing staff across the floor as a whole. The challenge of balancing these 2 priorities became apparent when Chiong-Oglesby was working on patient-nursing assignments during the time when the new hospital first opened and the Marathon patients formed the majority of patients on the floor.

All Spaulding patients are assigned a “primary nurse” upon admission who stays their primary nurse until discharge. However, to reduce “travel distances” for nurses in the new hospital, Chiong-Oglesby temporarily switched around a couple of nurse-patient assignments. The mother of one of the Marathon patients was not happy about that because of the bond that had developed between her 18-year-old daughter and one of the younger nurses. Recalled Chiong-Oglesby, “I talked with the nurses and we rearranged assignments so that the patient retained her favorite nurse. This situation reminded me of how important the bond between the nurse and his or her patient can be in helping the patient to get better.”

The strong bonds that formed between patients and clinicians were many layered, said physiatry resident Jennifer Earle, MD. “For me, this was the first time I’d taken care of multiple patients from the same family,” she said, “and that itself brings you into the family circle.” Because many of the patients were young, their interactions with the health care system and their personal experience of being dependent on others were limited. In Earle and other young clinicians, these patients found people who could help them navigate physically and emotionally through the complicated bureaucracy of health care.

Irene and Darrell Davis reunited with Michele Mahoney while she was still hospitalized at BIDMC. “The first time I talked to Irene in the hospital, it was like I’d known her forever,” said Mahoney. “The bonding that magically forms between gravely injured people and those who help them is real,” agreed Irene. “We will always have that connection with Michele.” Later, the Davises joined Michele and her family during what was for Michele a wheelchair-assisted visit to the bombing site (see photo below).

Michele also developed an extra-tight bond with her visiting nurse when she was recuperating at her parents’ home west of Boston. When the nurse called Mahoney’s primary care doctor’s office to order a prescription refill and the receptionist balked, the nurse shouted, “Michele’s been blown up!” That’s the kind of advocacy that Michele appreciated.



Physical therapist Irene Davis, PhD (left), a medical tent volunteer on the day of the Marathon bombings, was one of the first clinicians to treat Michele Mahoney (center) after the explosions. Michele’s mother Sharon (right) joined Irene and Michele for a visit to the bombing site.

Part 3: The Road Ahead

A Long Haul for Each and All

Chapter 10

Lifelong Challenges and Patient-Clinician Relationships

Most people look forward to time-limited, episodic relationships with their health care providers. But when thinking about his Marathon patients, David Crandell, MD, physiatrist and medical director of the Amputee Program at Spaulding Rehabilitation Hospital, said, “I’ll be following some of them for the rest of my career.” Such lifelong patient-physician relationships are somewhat unique in today’s health care system, but many people injured in the 2013 Marathon bombings and their caregivers will experience them.

As the transitions from acute-care setting to rehab hospital and from rehab to home take place, for amputees, the realization of lifelong outpatient visits takes hold. “Most prosthetics need frequent revisions and reformulations, especially during the first year as the residual limb undergoes changes,” explained Jennifer Earle, MD, a physical medicine resident at Spaulding. That may entail lifetime relationships with a rehab physician, physical therapist, and prosthetist. Earle likens this to the lifelong relationships people who have chronic conditions, such as diabetes, have with their clinicians.

Long-Haul Physical Therapy

Even for nonamputee Marathon patients, “recovery is a very long process,” said physical therapist David Nolan, DPT. At the time Nolan and his Marathon patient Kaitlynn Cates were interviewed, her therapy routines had transitioned from predominantly soft tissue work (massaging around the graft to reduce adhesions and loosen scar tissue) to strengthening exercises, including jumping, balancing, and shallow squats (see photo on page 42).

Were it up to Cates alone, she might push herself too far, too fast. “She has the mind of an athlete, and she’s determined to get back to tennis and running,” said Nolan. “Sometimes I have to rein her in.” Therein lies one of the tightropes that physical therapists walk with their patients—having to push those who are reticent for whatever reason, and gently ratcheting back the eagerness of those who want rapid progress.

Adding to the risk for Cates of pushing too hard is the fact that she lost some sensory nerve function in the area of her injury, so her perception of pain is minimal. “Because of that, she could overdo things and not feel the pain and know when to stop,” said Nolan. The sensory nerve loss also prompts Nolan and Cates to work together on proprioception and body awareness on both her injured and contralateral sides. Citing research suggesting that sensory nerves can regenerate at the pace of a millimeter a day, Nolan is hopeful that Cates’ hyposensitivity will eventually return to normal.

As this report went to press, Cates had just had plastic surgery on her leg, and she knows that will entail post-operative weight-bearing limitations and some degree of immobilization. That will mean losing some of the muscle strength she worked so hard to regain. “I understood what my options were,” she said, “and the consequences of them. Running the Boston Marathon is on my bucket list and I hope to do it. Dave is shaping my PT around my goals and aspirations.”

Thanks to her own determination and the quality of the inpatient, at-home, and outpatient care she received, Michele Mahoney was walking quite well 4 months after the bombings, and she ran a 5K race only 7 months af-



David Nolan, DPT, clinical specialist at MGH Sports Physical Therapy, monitors Marathon patient Kaitlynn Cates as she works on strength and balance.

ter being injured (see photo above right). Doctors initially predicted that it would take 7 or 8 months for the level of recovery she achieved in 4, and they probably weren't even thinking about when she might again run a 5K.

For Mahoney, inpatient physical therapy at Spaulding focused on basics such as walking from bed to toilet, navigating stairs, and getting into and out of vehicles. Physical therapist Irene Davis put it this way: "Inpatient physical therapy is usually about *can* you do it. At the outpatient level, we look at *how* you do it."

One minor setback for Mahoney occurred as a result of her expectation that when she got out of the boot she wore for several months, she'd be walking well immediately, but her ankle mobility was still quite compromised. Her physical therapist at that time asked her what her goals were. "I wanted to get back to my apartment and job in Boston and to drive, and she really pushed me," said Michele.



Michele Mahoney and her boyfriend Jim Blackburn after finishing the Boston River Run 5K race, only 7 months after Michele's legs were seriously injured in the Marathon bombings.

And Mahoney pushed herself. She did her at-home exercises religiously and went to the gym on days she didn't have scheduled physical therapy. At the gym, she'd do the elliptical, the bike, or anything she could do without pain.

The best recipe for success in long-term rehab cases like Mahoney's is support from family and friends, excellent clinical care, and the motivation and determination of the patient. Michele said she got one great piece of advice from her physical therapist at Beth Israel Deaconess Medical Center, who at that early stage focused mainly on weight bearing and taking the first few steps. "Back then, I was getting praise and positive feedback for taking a step," Mahoney recalled. "She cautioned me that future progress would be less dramatic, and it was. I'm glad she warned me about that because having expectations and not realizing them can be very demoralizing."

Mahoney also expects that the psychological impacts of her experience will be with her for a long time. "I hope to

raise children some day, and I expect that I'll be an overprotective parent because of what happened to me," she said.

My Friend the Prosthetist

The amputee-prosthetist relationship is a uniquely long-term—sometimes lifelong—relationship. “A prosthetist is a person people with above-the-knee amputations get to know extremely well,” said Marathon patient Roseann Sdoia. So she took the advice of a representative of the Amputee Coalition who visited Spaulding and of several wounded warriors from the Semper Fi Foundation group: she shopped around for a prosthetist. “I was prepared to interview 6 to 8 prosthetists, but I stopped at number 4, because it just seemed right,” she said. “You need to click with your prosthetist.”

The prosthetist Sdoia clicked with was Arthur Graham at Next Step Bionics and Prosthetics. Graham recalled that when Sdoia first visited him while interviewing prosthetists, she came armed with 2 pages of questions. “It felt like a job interview, but I applaud her for doing her research and recognizing how important the decision was,” he said.

Sdoia's first postinterview visit with Graham was a day-long affair. She had a plaster cast made of her residual limb and 2 hours later tried on a so-called test socket—a rigid, glass-like version of the more flexible socket that would eventually hold the residual limb. For the next 2 hours, she and Graham worked together to make the adjustments to the test socket that translated into the final socket, which took about 2 additional days to make.

Graham often encounters patients coming to their initial consult waving web-generated specifications for the prosthetics they think they want. “We see ourselves as a filter between the patient and manufacturer information on the Internet,” Graham said. “We're diligent about making sure the component selected fits the patient's lifestyle.”

The artificial knee joint in Sdoia's prosthesis has 6 microprocessor-based sensors and a gyroscope, allowing it to sense ups and downs in terrain and to get cues from the opposite leg. “I still have to swing and load the leg,” said Sdoia, “because the knee has no power of its own, but it sort of knows where it is in space and in relation to the other leg.”

Her prosthesis, originally designed for military applications but recently made available for civilian amputees, is also completely waterproof, so Sdoia can shower and swim without having to remove it.

The day Sdoia was interviewed for this special report, she'd had her second prosthetic socket for a week, and she was not having a good time with it. The cuff was too tight and it hurt to walk. She needed that second prosthetic because, even in the short time she'd had the first one, her residual limb had shrunk, changed shape, and no longer fit properly inside the prosthesis.

Early on, the greatest challenge for amputees is “managing the volume” of the residual limb, which tends to shrink over time. Shrinkage is most rapid and pronounced during the first 3 to 6 months after surgery, and socket adjustments and remoldings are frequent during this time. Shrinkage plateaus after that, but the shape and size of the residual limb never remain totally constant. Hence, the lifelong relationship between a patient with an amputation and his or her prosthetist.

“Once you get your first prosthesis, you might think you're ready to go,” Sdoia said. “It's not that simple, though.” Prosthetic adjustments are challenging for both patient and prosthetist. “Any time skin comes up against a harder surface, the skin usually loses,” Graham said. “Over time, a prosthetist gets to know what patients like and don't like in the socket fit.”

Prosthetic fit is such a moving target that Graham sometimes receives text messages from patients with photos embedded and questions such as, “Does this look right?”



Roseann Sdoia, who had an above-the-knee amputation as a result of the Marathon bombings, discusses the fit of her socket with prosthetist Arthur Graham at Next Step Bionics and Prosthetics.

He can often tell remotely whether a person needs to come in or can make an at-home adjustment.

Sdoia admits it's hard not to get discouraged when prosthetic problems arise. "I don't want to get back on crutches," she says, referring to one consequence of a prosthesis being out of adjustment and too painful to wear. "It was liberating to be able to walk around my apartment

without any crutches and have both hands free," she said. Resorting to even 1 crutch to deal with pain feels like a major setback, she said.

Even on the best, pain-free days, with a new prosthesis every movement has to be thought about in advance. "Everything takes longer now," Sdoia said. "I was habitually late before this. Now I'm *really* late."

Chapter 11

Continuous Improvement

Preparedness experts and clinicians have many things in common. One of them is that no matter how well things might have gone today, they are always looking for ways to improve next time.

As well as the transition from planned mass-casualty event to actual mass-casualty event went on April 15, Kurt Schwartz, director of the Massachusetts Emergency Management Agency (MEMA), knows it could have been even more seamless and efficient. For example, Schwartz noted that the forward command center established at the Westin Hotel, close to the bombing site, didn't immediately have all the resources it needed, such as satellite phones, maps, and computers.

To address this and other gaps, MEMA and the state Department of Public Health (DPH) have convened a mass-casualty working group consisting of emergency medical services leaders, the DPH's Office of Preparedness and Emergency Management, 10 hospitals, public safety representatives, and the American Red Cross. The working group drilled deeply into the 2013 event to determine what needed to be improved for the following year.

Communication with the public is one of those areas, Schwartz said. To that end, a working group subcommittee is designing a joint information center, where the public information officers from all agencies can confer and push out jointly vetted communications. Added Newton-Wellesley Hospital's Terry Gustus, "This is especially important for populations such as the elderly, those for whom English is neither spoken nor written, and those with impairments in vision, hearing, or cognition."

Schwartz also thinks a slightly better job could have been done with the estimated 5000 to 7000 runners still on the course when the bombs went off. "We did pretty well making this up as we went, but we need to think about improvements in communicating with, sheltering, and

transporting those people, and reuniting them with their families," he said.

Terry Gustus appreciates the importance of emergency-preparedness collaboration at the state and federal levels, but she's also interested in improving collaboration closer to home and hospital. "I think there could always be better coordination between hospitals and local public safety and human services agencies," she said. She would like to see citywide incident command systems that merge separate incident command systems for hospitals with local fire and police. "That would help everyone better understand who's responsible for what and avoid duplication," she said.

Mental Health Opportunities

Schwartz also thinks the system responded well to the needs for crisis counseling, but he thinks enhanced planning would lead to better delivery of such services to thousands of people. Deborah Allen of the Boston Public Health Commission (BPHC) agrees. Based on the bolus of needs in the bombing

aftermath, she is preparing a request for proposal to develop a master list of mental health clinicians, generalists and specialists, who she can vet and credential in advance.

"If we can get providers on a master contract in advance, it will be easier to respond quickly to the broad array of requests that come in after a disaster," she said. Already in existence is a statewide group of precertified disaster mental health providers that is coordinated by the state Department of Mental Health.

Allen is also participating in a working group with her colleagues in the Office of Public Health Preparedness, comprising local, state, and federal partners, including the American Red Cross, to revise the family assistance center plan for quicker postdisaster implementation.

At the level of individual mental health, behavioral researchers at Spaulding are preparing to measure longer-term behavioral follow-ups among the Marathon patients.

“If prosthetists are brought into discussions early, they can remove some of the mystery for patients about what life as an amputee will be like.”

Measures might include how many qualify for a diagnosis of posttraumatic stress disorder, depression, or anxiety; how many return to work; and what the substance use and abuse patterns are among this cohort. “This presents a rich research opportunity,” said Spaulding’s Chris Carter, “but our main concentration at the time was making sure patients’ emotional needs got taken care of.”

Structured Reporting

The opportunity for improvement in communications among all the entities involved in the emergency response got Paul Biddinger, MD at Massachusetts General Hospital (MGH) thinking about structured situational reporting. A list of standardized questions to be asked by and answered by each stakeholder, Biddinger theorizes, would help solve the too-much-information problem that sometimes clutters communication during an emergency. “Secure information portals like the WebEOC are tremendously helpful,” he said. “But there could be more standardization to the communication to prevent oversharing and undersharing of information.”

While structured reporting might be something around which the DelValle Institute could develop a course, the institute’s senior program manager, Brian Pomodoro, has already started a class on improvised tourniquets as a result of the Marathon bombings. “We dove right back into training after the bombings, with no hesitation,” he said. At a more macro level, DPH, BPHC, and other stakeholders are working on policies and procedures to allow the DPH to be the clearinghouse for patient information during a disaster.

At Brigham and Women’s, the existing patient identification system turned out to be insufficient for the influx of so many patients with no known names. “We typically use sequential medical record numbers for new patients,” the Brigham’s Jonathan Gates, MD explained. “We are used to getting patients without known names, but that day we got a lot all at once, and we had to be very careful to distinguish one medical record from another because all we had to go on was the record number.” No errors were made, but with the potential for mistakes recognized, within 5 days after April 15, Brigham and Women’s implemented a new policy for unnamed patients—they now are randomly assigned the name of a town in Massachusetts to go along with their medical record number.

Clinician to Clinician

Spaulding physiatrist David Crandell, MD knows that the first thought of a trauma team faced with a patient presenting with life-threatening bomb-blast injuries is probably not the downstream rehabilitation process. But he thinks that vascular, orthopaedic, and trauma surgeons could understand more about what amputees and limb-sparing patients face in rehab, and he encourages these clinicians to take an extra moment to think about the important first steps in rehab when considering treatment approaches.

Similarly, prosthetist Arthur Graham understands that surgeons trying to save a patient’s life or limb following an event like the Marathon bombings might not have prosthetic fitting as a top-of-mind concern, but he wishes surgeons would be more collaborative with prosthetists. He credits MGH’s chief of trauma surgery, Malcolm Smith, MD, with inviting prosthetists to train with surgical residents. “If prosthetists are brought into discussions early, they can remove some of the mystery for patients about what life as an amputee will be like,” he said.

In a larger-scale clinical continuous-improvement effort, within weeks after the bombings, the trauma service directors from all Boston teaching hospitals convened a consortium to get a citywide view of how the event was handled, what training had proved successful, and what needs to be done better in the future.

That hospital-to-hospital networking is nothing new for Jonathan Gates and his Brigham and Women’s colleagues. They often share what they’ve learned as a level 1 trauma center with other hospitals. “It’s important for all hospitals to be ready, no matter what their trauma designation,” he said. “Preparedness is one of our core competencies, and we’re in a position to help other hospitals understand and implement those principles.”

Despite the nearly unanimous agreement that the response to the Marathon bombings was effective and saved many lives, there’s no resting on laurels for the Conference of Boston Teaching Hospitals’ (COBTH) emergency management coordinator Mary Devine and her colleagues throughout the preparedness community. “We tend to gloss over what went right and focus on what could’ve been done better,” she said. “The few things you did right don’t keep you up at night. The one thing you did wrong does.”

Chapter 12

Funding and Regionalization

In a year that saw a federal government shutdown and a near-default on the national debt, no one is certain about funding for anything. But when it comes to preparedness funding, the BPHC's Atyia Martin says the best hedge against losing funding is getting early and regular wins under your belt and showing stakeholders at all levels the benefits of being collaborative. "The fact that the community knows what we do and what we did before and after the Marathon gives me some hope about ongoing funding to sustain and enhance capabilities that proved invaluable this year," said Martin.

Where the Money Comes From

The BPHC's Office of Public Health Preparedness is predominantly funded by federal grants; that includes the staff that support public health, health care, and community preparedness; training and exercises through the DelValle Institute; and the Medical Intelligence Center. "Without this funding, we would lose many of the strides that public health, EMS, and health care have collaboratively gained," Martin said. The sources of grant funding include the US Centers for Disease Control and Prevention's (CDC's) Public Health Emergency Preparedness grant, the US Health and Human Services Assistant Secretary for Preparedness and Response (ASPR) Homeland Security Grant Program, and the National Association of County and City Health Officials.

Mary Devine's emergency management position with COBTH is half funded by a yearly federal grant from ASPR, awarded through the DPH. The other half comes from dues from COBTH's 14 member hospitals. "If the federal money went away, I'm quite confident that we would find the money to support preparedness among the member hospitals," said COBTH executive director John Erwin. Making up any federal shortfall through other grants, however, would be difficult for COBTH. As

a 501(c)(6) entity, it engages in advocacy activities and is therefore not eligible for most grants.

Funding of nonsalary resources for the Hospital Preparedness Program also comes from ASPR, and that support for 2013 was 30% lower than the prior year. And because this ASPR funding is year to year, there's no long-term guarantee of funding.

"No one will probably ever ask me this again, but people used to ask why we spend so many resources and so much money on the Marathon," said MEMA director Kurt Schwartz. "All that communication and coordination on Marathon day was possible because of planning and exercises, and it was supported largely by funding from federal Homeland Security." Schwartz can only hope such support is sustained.

At a more microeconomic level, MGH takes a cost-of-doing-business approach to funding preparedness. MGH builds preparedness into the hospital-wide operations budget, although there is a separate budget for capital equipment related to preparedness.

This approach, said MGH's Paul Biddinger, prevents the nickel-and-diming that managers sometimes practice with departmental preparedness budgets. "Here, preparedness is a cross-cutting, common obligation,"

Biddinger said, "and people are eager to participate. Removing it from a budget conversation makes for a very collaborative mindset about preparedness."

The DelValle Institute's Brian Pomodoro knows hospital budgets are tight around every line item, including preparedness, so he advises organizations to curtail capital expenditures of preparedness equipment if necessary, but not to cut training. "Without training, the equipment might as well be locked in a closet," he said.

One big-budget hospital Pomodoro has visited has fancy equipment but mediocre training, while another has a decontamination unit consisting of a kiddie pool and gar-

"If you want regions to work together, you have to encourage regional exercises—and fund them."

den hose. “The people at the second hospital are so well trained that I would pit their decon system against anyone’s,” he said.

Regional Coalitions

The Office of Preparedness and Emergency Management of the state DPH is funded by 3 sources, 2 of which are federal (the CDC and ASPR), and the state, which is required to match 10% of the federal funding.

In turn, the DPH provides funding to support preparedness activities for the 351 cities and towns in the state, as well as hospitals and other health care organizations. While acknowledging that “emergencies always start locally,” the DPH’s Mary Clark knows that such a decentralized approach to preparedness in an era of dwindling funding is not sustainable. So beginning in 2004, Massachusetts established emergency-preparedness regions, forming 7 public health-preparedness regions that include 15 voluntary local preparedness coalitions and 6 hospital regions. Such regional preparedness coalitions are also forming in more rural parts of the United States.

Ongoing efforts to develop regional planning and response capabilities in Massachusetts seek to engage not only local public health officials and hospitals but also community health centers, emergency medical services, and long-term care facilities. Clark concedes that there is work to be done to fully integrate these newer players in regional planning and response activities, and for these core health and medical disciplines to fully understand each

other’s roles, responsibilities, and missions—and to answer complicated questions about reimbursement for and coordination of preparedness and response activities.

For Clark and her colleagues, the second half of 2013 included statewide road trips to all coalition and hospital regions to answer questions about establishing health and medical coordinating coalitions to support regional planning and response. “It’ll be a challenging year of discussions,” Clark said, but she and her colleagues will have the response to and recovery from the Marathon bombings as compelling evidence that such regional collaboration is crucial.

With the push toward regionalization, Paul Biddinger is convinced that “the future is coalitions where resources are aggregated.” It’s a hard sell, he admits, with many well-entrenched policies and procedures—and the home-rule structure—working against it.

“Regionalization would offer economies of scale and efficiency,” said Biddinger. “Boston is only 1 of 2 multidisciplinary formal response regions in effect now, but other parts of the state have made good progress in regional planning as well.” Overall, Biddinger estimates that Massachusetts is “10% to 20% on the way to regionalization,” with some still very siloed portions of the state.

Biddinger said there’s little doubt that public funding for preparedness exercises is dwindling. This fact argues for continued regional and cross-jurisdictional approaches to planning and exercising. “If you want regions to work together, you have to encourage regional exercises—and fund them,” Biddinger concluded.

Epilog

“Fortune favors the prepared mind.” – Louis Pasteur

“The readiness is all.” – Hamlet, Act V, Scene 2

The medical teams that responded to the Boston Marathon bombings were prepared—they had carefully and diligently learned from the experiences of those who met earlier challenges, including domestic and international tragedies. Our intent with this special report is to help health care teams throughout the United States and around the world prepare for whatever might come next—from natural disasters to human conflicts.

With all unexpected events, the first moments after the world changes are critical. Explicit throughout this report is the importance of everyone knowing where to go and what to do in the initial, crucial moments of an emergency. This is the essence of teamwork and preparedness—knowing your role, being ready to assume it at a moment’s notice, and respecting the contributions of others—both in the short run and the long haul. Indeed, preparedness and teamwork continue to characterize those health care professionals who are meeting the needs of men, women, and children still recovering and healing months after the news media have packed up and moved on.

In this instance, as in so many others, the broader community also played a part. People from all walks of life rallied around the teams described in this special report, with One Fund Boston generating millions in donations to support those directly affected by the bombings, funds that were distributed in a matter of weeks after these terrible events. Families, teams, and entire communities gave of themselves to thank the first responders, support survivors, and assist with clean-up and rehabilitation efforts.

These efforts culminated in the inspiring moment when players from the Boston Red Sox—a baseball team that dedicated its season to the Marathon event—set their World Series trophy, draped with a Red Sox jersey numbered “617” (Boston’s area code), at the Marathon’s finish line. In this way, as millions watched, the 2013 Boston Marathon finally reached its conclusion—as one highly visible team paid tribute to the dozens of other behind-the-scenes teams like those described in this special report.

No matter what happens during the 2014 Boston Marathon, teams of highly trained and dedicated health care and preparedness professionals will be ready.



Appendix

Newton-Wellesley Hospital Marathon Planning Checklist: 2013

Emergency Department (ED)	<input type="checkbox"/> Confirm that ED documentation software link is loaded on gastrointestinal (GI) computers <input type="checkbox"/> Med tackle box for GI <input type="checkbox"/> Patient Tracking staff <input type="checkbox"/> Department of Public Health (DPH) in Decon/ambulance bay <input type="checkbox"/> Patient Tracking staff after DPH leaves <input type="checkbox"/> All patients to be directed to ED for triage <input type="checkbox"/> Long-distance calling code for ED and GI <input type="checkbox"/> Taxi vouchers <input type="checkbox"/> Blue bracelets (in triage cart in Decon room) <input type="checkbox"/> Contact command center if any elite runner presents <input type="checkbox"/> 2 ED nurses in GI to enter in ED tracking system <input type="checkbox"/> Process to return elite runner (add to Frequently Asked Questions [FAQs]) <input type="checkbox"/> Training for staff in ice immersion <input type="checkbox"/> Email FAQs to all ED staff prior to marathon <input type="checkbox"/> ED will flag lab tests for critically ill patients as Code/Stroke and also call the lab <input type="checkbox"/> Interpreter Phone on a Pole (IPOP) needed for GI and ED (Transport will bring one to GI) <input type="checkbox"/> Provide taxi vouchers to college students if schools will not pick them up on discharge
Facilities	<input type="checkbox"/> Verify electrical and water hookups operable in front of Cancer Center <input type="checkbox"/> Ensure brush clear from alternate road entrance <input type="checkbox"/> Make sure signage is removed during grounds cleanup <input type="checkbox"/> Order Port-A-Potties (charge cost to facilities)
Nutrition	<input type="checkbox"/> Ensure delivery of Gatorade, bouillon, coffee urns, and pretzels to ED by Friday <input type="checkbox"/> Large cups with straws and lids <input type="checkbox"/> Bottled water and Cans of Gatorade on ice in ambulance bay for Emergency Medical Services (EMS) <input type="checkbox"/> Same in East and West Lobby behind desk (small quantity) <input type="checkbox"/> Contact person with Food and Nutrition on race day to request attendance at preplanning meetings and briefings in command center <input type="checkbox"/> Stage portable freezer and ice in decon room
Transport	<input type="checkbox"/> Transporters will be in East and West Lobby. <input type="checkbox"/> Wheelchairs and stretchers available <input type="checkbox"/> All patients who present are to go to ED <input type="checkbox"/> Interpreter available? <input type="checkbox"/> IPOP to GI by 9 AM
Materials Management	<input type="checkbox"/> Supply carts to ED and GI by 9 AM
Pharmacy	<input type="checkbox"/> Hypertonic saline to ED nurse manager <input type="checkbox"/> Med tackle box for GI to Minor Treatment Unit leader
Environmental Services	<input type="checkbox"/> Process for cleaning tub
Administration	<input type="checkbox"/> Email to doctors and Intensive Care Unit (ICU) regarding early discharges on Monday
Nursing	<input type="checkbox"/> Nursing supervisor coverage list to emergency management coordinator
Public Affairs	<input type="checkbox"/> Map and memo to patient floors on Sunday with time of road closing <input type="checkbox"/> Housewide memo regarding road closure <input type="checkbox"/> Communicate with urgent care regarding directions to campus <input type="checkbox"/> Public Information Officer will be notified by command center if any elite runner presents in ED <input type="checkbox"/> Signage for outpatient surgical center—front and back doors

Radiology	<input type="checkbox"/> Verify that Picture Archiving and Communication software is loaded on GI computers <input type="checkbox"/> Patients in GI needing diagnostic imaging will go to the main radiology department <input type="checkbox"/> Please enter location of patient when entering exam orders (ED versus GI)
Public Safety	<input type="checkbox"/> Check Washington Street for parked cars (towing will begin at 7:45) <input type="checkbox"/> Mass Decontamination Unit setup <input type="checkbox"/> Block parking spaces at West Entrance <input type="checkbox"/> Set ambulance entrance door to open access <input type="checkbox"/> Coordinate traffic flow on alternate road (8 AM to approximately 4 PM) 1 hour before and after close/open of Washington Street <input type="checkbox"/> Block Employee Garage roof for ambulance staging <input type="checkbox"/> Security cameras projected in Command Center <input type="checkbox"/> Fire apparatus on site. Stage next to Allen Riddle
Emergency Prep	<input type="checkbox"/> Regional mutual aid coordinating entity (MACE) book <input type="checkbox"/> Command Center staffing <input type="checkbox"/> Purchase rectal thermometer <input type="checkbox"/> Shelter information to Newton Police Department <input type="checkbox"/> Megaphones <input type="checkbox"/> Tub setup <input type="checkbox"/> Decon shower cleared as of 6 AM
Lab	<input type="checkbox"/> ED will flag critically ill patients as Code/Stroke and also call the lab
Communications	<input type="checkbox"/> Patient-announcement line with directions <input type="checkbox"/> Staff emergency-announcement line <input type="checkbox"/> Provide GI with phones to use in patient room phone jacks <input type="checkbox"/> Switchboard to make announcement at 7:00 AM and 7:30 AM regarding parking on Washington Street. Towing will begin at 7:45

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sympathy, admiration & appreciation

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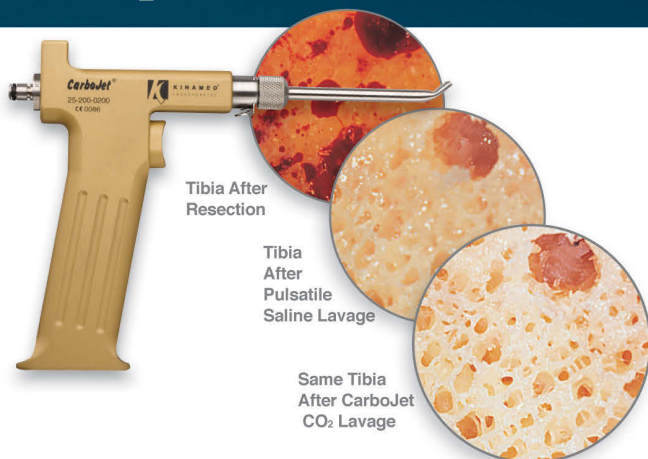
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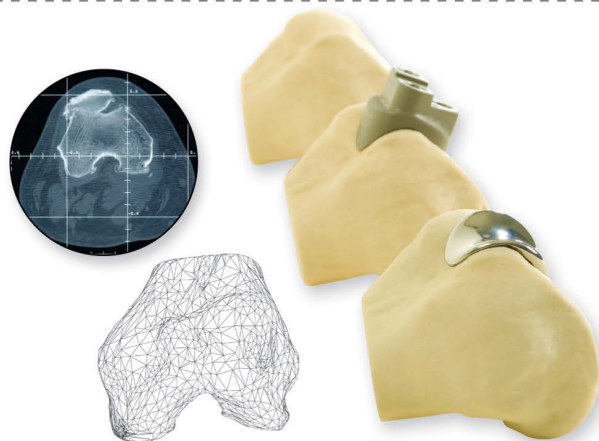
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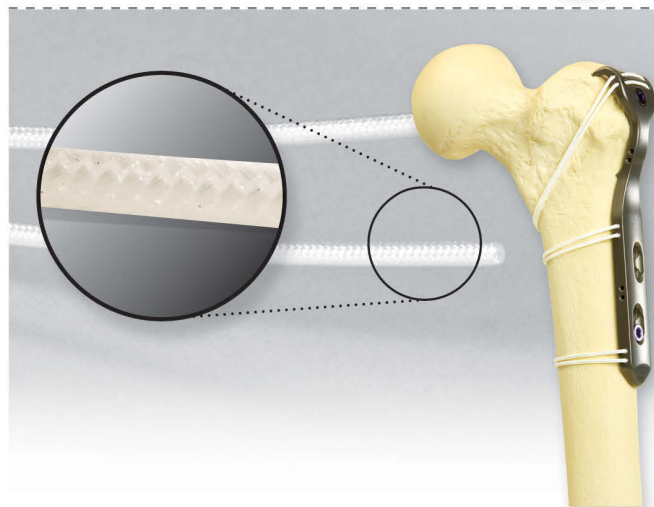
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Urban et al (2004) Accumulation in liver and spleen of metal particles generated at nonbearing surfaces in hip arthroplasty. J Arthroplasty 19:94.

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Sarin, Mattchen, Hack (2005) Novel iso-elastic cerclage cable for treatment of fractures. ORS. Washington, DC.

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Stoker (2009) Advances in Internal Bone Fixation: Sharps Safety for Orthopedic Surgeons. Managing Infection Control. 9:30.



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