

# The Processing of Surgical Specimens With Forensic Evidence

## Lessons Learned From the Boston Marathon Bombings

Cathryn J. Byrne-Dugan, MD, MPH; Terra A. Cederroth, MD; Anita Deshpande, MD; Daniel G. Remick, MD

• **Context.**—Following the Boston Marathon bombings in April 2013, pathology departments at hospitals across Boston, Massachusetts received numerous amputated limbs, as well as other surgical specimens from trauma surgeries. In the absence of clear guidelines, each department faced uncertainties in performing gross examination of these specimens.

**Objective.**—To develop a protocol for processing surgical specimens with forensic evidence.

**Design.**—We collaborated with representatives who knew the practices at 3 major Boston hospitals, the Office of the Chief Medical Examiner of Massachusetts, and a senior team leader for the evidence response team for the Boston, Massachusetts division of the US Federal Bureau of Investigation to construct a protocol for processing specimens with forensic evidence.

**Results.**—A simple and robust protocol approved by

experts in forensic evidence collection was developed. Important points in this protocol include (1) assigning the task of processing the specimens to one individual or one team of individuals, (2) photographing all specimens before and after washing, (3) obtaining a radiograph of each specimen, and (4) identifying a secure area to store forensic evidence.

**Conclusions.**—When acts of terror occur, protocols provide order and clarification to the processing of surgical specimens. We propose a protocol that provides guidance for pathology departments across the country to handle trauma-related surgical specimens with forensic evidence in an efficient manner to allow optimal patient care and a secure way of gathering forensic evidence.

(*Arch Pathol Lab Med.* 2015;139:1024–1027; doi: 10.5858/arpa.2014-0441-OA)

On April 15, 2013, 2 pressure-cooker type bombs detonated near the Boston Marathon finish line, killing 3 people and injuring an estimated additional 264 people.<sup>1</sup> The bombing victims were treated at the Boston, Massachusetts area's 6 major trauma centers and other local hospitals for a multitude of injuries, most of which included blast and penetrating trauma to the lower extremities.<sup>2</sup> The rapid influx of many severely injured patients, the types of injuries involved, and the chaos of the situation presented hospital workers with many unfamiliar challenges.<sup>3</sup> Academic pathology departments across Boston, Massachusetts were no exception, receiving traumatic and surgical amputation specimens, virtually all of which contained forensic evidence, with no protocols in place for proper retrieval and processing. These specimens were received during the

interval when the suspects were at large, making appropriate collection and retention of forensic evidence critical.

The major trauma centers in Boston, Massachusetts reported that 16 people required amputations, with 8 below-the-knee amputations, 6 above-the-knee amputations, and 2 people required double amputations.<sup>4</sup> In these hospitals, the amputated limbs were sent to the pathology laboratory for processing, as would any other type of routine surgical specimen. However, many of these limbs contained foreign material that constituted medicolegal evidence—a situation that is infrequently, if ever, encountered by pathology staff in academic institutions. Because of the nature of the improvised explosive devices used by the bombers, dozens of pieces of shrapnel, ball-bearings, metallic beads, nails, zippers, and pieces of clothing had been blasted deep into the tissues and bones.<sup>2,5–7</sup> Furthermore, some of the limbs were extensively burnt, with adherent clothing and makeshift tourniquets, all of which, represented dilemmas for appropriate processing.

Confusion and uncertainty regarding these specimens led some pathology departments to seek guidance from the US Federal Bureau of Investigation (FBI), as well as the Massachusetts Office of the Chief Medical Examiner, to clarify collection procedures for forensic evidence and proper documentation of injuries. However, in light of the chaos in the days following the bombings and the ongoing investigation, answers were not always readily available.

Accepted for publication November 4, 2014.

Published as an Early Online Release December 18, 2014.

From the Department of Pathology, Boston University Medical Center, Boston, Massachusetts (Drs Byrne-Dugan, Deshpande, and Remick); and the Department of Pathology, Beth Israel Deaconess Medical Center, Boston (Dr Cederroth).

The authors have no relevant financial interest in the products or companies described in this article.

Reprints: Cathryn J. Byrne-Dugan, MD, MPH, Department of Pathology, Boston University Medical Center, 670 Albany St, Boston, MA 02118 (e-mail: cathryn.byrnedugan@gmail.org).

## Protocol for Handling Surgical Specimens Containing Forensic Evidence

### Specimen Arrival and Identification

- Identify one person or team who will handle all specimens and will report results
  - *Recommendation: One pathologists' assistant and/or resident and one attending physician*
- Specimen arrives via courier from operating room or emergency department
  - Accession case, and confirm that each case has 3 patient identifiers
  - Sealed containers received from operating room with foreign bodies should remain sealed

### Gross Examination of Surgical Specimen

- Obtain plain film radiographs of specimen in anteroposterior and lateral views
- Photograph and diagram specimen with an accession label as it is received
  - *Recommendation: Photographs should have limited, password-protected access*
- Remove any superficial loose objects (eg, make-shift tourniquets, clothing, etc), and place items in a container for FBI or police with 3 patient identifiers
- Describe lacerations, fractures, burns, remaining foreign bodies (locations, types), and results of radiograph
  - *Note: Examine and comment on the viability of tissue at the resection margin(s)*
- Wash specimen, and take additional pictures
  - Document any additional information obtained after cleaning the surgical specimen
- If there is an indication (eg, osteomyelitis, chronic ulcer), submit sections of resection margin(s) or other lesions
- As reasonably appropriate, remove foreign bodies from the surgical specimen, photograph them, and place them in a sealed container labeled with 3 patient identifiers
  - *Note: If there are numerous foreign bodies, making it difficult or impossible to remove all, remove a representative sample, and note that there are remaining foreign bodies in the specimen*
- All foreign bodies should be weighed, described, and measured
  - *Note: If foreign bodies are received in a sealed container, weigh them in their container, then subtract the weight of an empty container of the same type, and record the true weight in the gross description*

### Disposition of Surgical Specimens and Foreign-Body Containers After Gross Examination

- Place surgical specimens and sealed containers with foreign bodies in a locked, secure area with limited access; note that refrigeration may be necessary
- Contact FBI or local police to inform them that foreign-body evidence is ready
- Hold surgical specimens until patient is discharged (overflow specimens may need to be held in the morgue or alternative location)
- In the case of a patient death, surgical specimens and foreign bodies should be transferred to the medical examiner's office

Abbreviation: FBI, US Federal Bureau of Investigation.

Unfortunately, because of unfamiliarity and lack of a standard protocol, processing was largely improvised with different gross-examination procedures adopted by each institution.

In medicine, the benefits of checklists and protocols have been widely demonstrated, with the purpose of streamlining procedures into a well-defined sequence of actions, thereby harmonizing clinical practice by reducing human error.<sup>8,9</sup> Protocols are especially important in the setting of a crisis situation, where time, staff, and resources may be limited.

ed.<sup>10,11</sup> Following the terrorist attacks on the World Trade Center (New York, New York) in 2001, the Department of Justice published<sup>12</sup> a detailed and comprehensive protocol for processing specimens for DNA identification of deceased victims. In its report, the importance of a response plan before an incident occurs was highlighted with the comment that decisions made by the laboratory director during the first 48 hours are crucial for the overall efficiency and success of the effort.<sup>12</sup> In times of crisis, if there is no predetermined, planned approach, missteps are inevitable. Despite a number of published recommendations that address the retrieval of certain foreign objects, such as bullets from surgical specimens,<sup>13</sup> there is little literature on how to approach medicolegal evidence in surgical specimens. This lack of published guidelines paired with the lack of clarity noted by pathology staff following the Boston Marathon bombings brought to light the need for a gross examination protocol for surgical specimens containing forensic evidence.

## DESIGN

Local area pathology departments were contacted and representatives familiar with the practices of 3 major Boston hospitals with trauma centers were assembled. Each representative outlined the practices that were used to process the specimens at his or her hospital. Commonalities, as well as inconsistencies, were identified among these hospitals. Feedback from representatives about practices that were helpful and those that were unnecessary or difficult to perform was gathered. A draft protocol was designed and presented to area experts, including the chief medical examiner, the senior team leader of the evidence response team at the FBI, and a criminal prosecutor. The model was reviewed by a FBI representative and revised by 2 independent pathologists to assess its feasibility. After final edits, comments, and feasibility assessment from the pathology representatives, the protocol was finalized.

## RESULTS

A protocol was developed for the processing of surgical specimens with forensic evidence (Table). The protocol was divided into 3 distinct parts: (1) specimen arrival and identification, (2) gross examination of the surgical specimen, and (3) transfer of evidence/disposal of specimen.

The protocol begins by identifying a person or team who will handle all specimens and will report results. We recommend one pathologists' assistant and/or resident with an attending physician. Once it has been confirmed that the case is properly labeled with 3 patient identifiers, the case should be accessioned. Sealed containers received from the operating room with foreign bodies should be accessioned and left sealed.

To begin the process of gross examination of the specimen, plain film radiographs of the specimen in anteroposterior, lateral views should be obtained. Next, the specimen should be photographed and diagramed as it is received. Note that in all photographs, the accession label must be included. All superficial loose objects (eg, make-shift tourniquets, clothing, etc) should be placed in a container for the FBI or police and labeled with 3 patient identifiers (these objects should be noted to be found with, but not necessarily belonging to, that particular patient). Lacerations, fractures, burns, remaining foreign bodies (locations, types), and results of radiograph should be

described. The prosector should examine and comment on the viability of tissue at the resection margin(s). The specimen should be washed and then photographed again. If any additional information about the specimen is gleaned after washing, it should be documented. If there is an indication of other pathologic lesions (eg, osteomyelitis, chronic ulcer) sections should be submitted of resection margin(s) or other lesions. In some cases, a frozen tissue sample to be stored for later DNA analysis may be warranted. As reasonably appropriate, foreign bodies should be removed, photographed, and placed in a sealed container labeled with 3 patient identifiers. All foreign bodies should be weighed, described, and measured. If foreign bodies are received in a sealed container, weigh them in their container, then subtract the weight of an empty container of the same type, and record the true weight in the gross description.

After gross examination, the surgical specimens and sealed containers with foreign bodies should be placed in a locked, secure area with limited access; refrigeration may be necessary. The FBI or local police should be informed that foreign-body evidence is ready. The surgical specimens should be held until the patient is discharged (overflow specimens may need to be held in the morgue or alternative location). In the case of a patient death, surgical specimens and foreign bodies should be transferred to the medical examiner's office.

## COMMENT

We designed this protocol specifically to clarify common areas of confusion while processing specimens with forensic evidence and will use the remainder of this report to expand on the questions relating to who should process the specimens, how the specimen should be prepared (ie, is a radiograph necessary, should we wash the specimen, do we need to take sections), and how the specimen and evidence should be stored.

### Specimen Processing

**Team Approach.**—We recommend that a dedicated team, composed of a senior pathologist and one resident or pathologists' assistant, should be assigned to the processing of all specimens related to a large-scale trauma in which specimens contain forensic evidence. This recommendation is supported by the 9/11 DNA identification report,<sup>12</sup> which concluded that the response to a mass fatality incident should be handled as a separate project, rather than as a part of the laboratory's standard operation. The senior pathologist should act as the project manager and preferably be comfortable with forensic evidence, communicating with law enforcement and media, and attending court proceedings. The project manager would also be responsible for coordinating with human resources to supplement the capabilities of the laboratory if an event requires more staff involvement.<sup>12</sup> We recommend that the team meet before initiating the process of evaluating these specimens and discuss the approach and logistics. The senior pathologist should observe and assist in the process of initial implementation of the protocol as well as periodically check in with the resident or pathologists' assistant during the evaluation of the specimen. Of note, only one person should handle each specimen, per chain of custody guidelines.<sup>14</sup> A dedicated team approach minimizes confusion, increases consistency, and provides structure to

the process. It also provides law enforcement a point person for immediate and future communication.

**Radiographs.**—We recommend that pathology departments obtain plain film radiographs of each specimen in anteroposterior and lateral views. Radiographs are the ideal tool to document forensic evidence, including embedded foreign material, as well as to identify fracture and dislocation. Identification of foreign material also diminishes the potential of injury to the resident or pathologists' assistant involved in handling the specimen.

Many pathology departments do not have x-ray equipment in the laboratory; however, they usually have a process for coordinating with the radiology department to obtain radiographs on specimens. We strongly recommend that radiographs be obtained because they can be helpful in documenting and dissecting evidence from specimens in these situations. If criminal prosecution takes place, presenting the x-ray in court may be less inflammatory to the jury than showing gross photographs of the amputated limbs.

**Washing the Specimen.**—The first and foremost step is to document and photograph the specimen in the state in which it is received in the grossing area. Washing is only recommended after taking the initial photographs to allow the prosector to clearly visualize the wounds and to understand the injury, which should also be documented with photographs after washing. Most of the specimens we received were bloody, and only after washing were we able to properly document the location, nature, and severity of the injuries.

**Tissue Samples.**—In the Boston Marathon bombings, most specimens were received from young, healthy people, with no comorbidities. In these situations, we recommend that the team focus on the gross descriptions, measurements, photographs, and dissection of foreign bodies, when it is reasonably appropriate (ie, if there are many small, scattered foreign bodies, a sampling of the larger, more-accessible bodies is acceptable). Tissue sections may be helpful in documenting charred areas and for assessing the presence of underlying disease conditions, such as osteomyelitis, peripheral vascular disease, or diabetes. If the patient has no other comorbidities and there are no additional pathologic lesions, then it is appropriate for the team to forgo submitting sections. If the specimen is processed without tissue samples, we recommend a brief comment on the gross viability of the resection margins.

**Storage of Specimens and Evidence.**—Photographs and evidence should be stored in a secure manner. Ideally, digital images should be password protected, with access limited to the team handling the surgical specimens. This minimizes the risk of sensitive material being viewed, shared, or otherwise compromised. All evidence should be stored in a secure area after proper documentation. Smaller surgical pathology laboratories not equipped with a secure area should dedicate a cabinet, drawer, or room, in times of emergency, to be used for secure evidence storage. We also propose a single contact person identified in the department for all further communication with law enforcement.

### Chain of Custody

This report focuses on how to process the specimens received during a mass trauma event but does not detail the procedures related to chain of custody. In our experience, most institutions have a clear chain of custody procedure for forensic evidence, which is readily followed. During

incidences of mass trauma, the chain of custody should be meticulously documented during the transport and storage of the specimens according to each institution's policy. Some policies require that only one person handle each specimen. This should be addressed by the dedicated team approach, with only one pathologists' assistant or resident performing the gross examination of each specimen. We recommend documentation of every person who comes in contact with the specimen in the department of pathology at each step from accessioning until its release to law enforcement authorities; this, of course, is in addition to following the chain of custody for transporting the specimens to pathology.

## CONCLUSION

This protocol is a summary of the best practices based on our collective experience with the Boston Marathon bombings. It was a time of confusion and chaos in the Boston, Massachusetts community, and there were no guidelines available on how best to process surgical specimens. Our hope is that, if there are future incidences of mass traumas, this protocol and its recommendations will serve to assist others by guiding their process with simple, concrete steps that have been validated by experts in the areas of forensic evidence collection.

We would like to thank Special Agent April Haddock, MFS, senior team leader for the Evidence Response Team within the Boston division of the US Federal Bureau of Investigation, and Henry M. Niels, MD, PhD, the chief medical examiner of Massachusetts, for their time and support in developing this protocol.

## References

1. Kotz D. Injury toll from Marathon bombs reduced to 264. *Boston Globe*. April 24, 2013. <http://www.bostonglobe.com/lifestyle/health-wellness/2013/04/23/number-injured-marathon-bombing-revised-downward/NRpaz5mmvGquP7KMA6XsIK/story.html>. Accessed December 20, 2013.
2. Dept of Homeland Security; Federal Emergency Management Agency. Boston marathon bombings: hospital readiness and response. *Lessons Learned*

*Information Sharing*. <http://www.hsdl.org/?view&did=744165>. Accessed January 2, 2014.

3. Kowalczyk L. Hospitals size up the lessons of marathon attacks. *Boston Globe*. <http://www.bostonglobe.com/lifestyle/health-wellness/2013/07/27/boston-hospitals-confronted-challenges-identifying-patients-after-marathon-bombing/7fFWuivM3tTKblFAyn1BIJ/story.html>. Accessed December 20, 2013.

4. Montgomery D, Sheridan MB, Bernstein L. Many Boston Marathon bomb victims cope with leg injuries. *Washington Post*. April 16, 2013. [http://www.washingtonpost.com/world/national-security/many-boston-marathon-bomb-victims-cope-with-leg-injuries/2013/04/16/ea6e07d6-a6c0-11e2-a8e2-5b98cb59187f\\_story.html](http://www.washingtonpost.com/world/national-security/many-boston-marathon-bomb-victims-cope-with-leg-injuries/2013/04/16/ea6e07d6-a6c0-11e2-a8e2-5b98cb59187f_story.html). Accessed December 13, 2014.

5. Kowalczyk L. Marathon victims take 1st steps down uncertain path. *Boston Globe*. June 29, 2013. <https://www.bostonglobe.com/metro/2013/06/28/marathon-bombing-amputees-get-prosthetic-legs-harsh-reality-hits-that-injuries-are-final/10VjCpi0Mg4e5kmBmLcKWl/story.html>. Accessed April 14, 2014.

6. Levitz J, Kamp J. Struggles of Boston Amputees Mount. *Wall Street Journal*. September 20, 2013. <http://online.wsj.com/news/articles/SB10001424127887324492604579083040654421528>. Accessed April 13, 2014.

7. Kantor I. Docs describe nails, BBs viciously blasted into Marathon patients. *Boston Herald*. April 16, 2013. [http://bostonherald.com/news\\_opinion/local\\_coverage/2013/04/docs\\_describe\\_nails\\_bbs\\_viciously\\_blasted\\_into\\_marathon\\_patients](http://bostonherald.com/news_opinion/local_coverage/2013/04/docs_describe_nails_bbs_viciously_blasted_into_marathon_patients). Accessed April 14, 2014.

8. Haynes AB, Weiser TG, Berry WR, et al; Safe Surgery Saves Lives Study Group. A surgical safety checklist to reduce morbidity and mortality in a global population. *N Engl J Med*. 2009;360(5):491–499. doi:10.1056/NEJMsa0810119.

9. Obaidullah, Farooq S. Clinical protocols: introduction to a useful strategy in clinical practice. *J Pak Med Assoc*. 2000;50(10):354–357.

10. Lingard L, Regehr G, Orser B, et al. Evaluation of a preoperative checklist and team briefing among surgeons, nurses, and anesthesiologists to reduce failures in communication. *Arch Surg*. 2008;143(1):12–17; discussion 18. doi:10.1001/archsurg.2007.21.

11. Institute of Medicine. *Crisis Standards of Care: Summary of a Workshop Series*. Washington, DC: National Academies Press; 2010. *Forum on Medical and Public Health Preparedness for Catastrophic Events*.

12. Office of Justice Programs. *Lessons Learned from 9/11: DNA Identification in Mass Fatality Incidents*. Washington, DC: US Dept of Justice; September 2006. <https://www.ncjrs.gov/pdffiles1/nij/214781.pdf>. Accessed November 3, 2014.

13. Education Standards Committee. *AST Standards of Practice for Handling and Care of Surgical Specimens*. Littleton, CO: Association of Surgical Technologists; April 13, 2008. [http://www.ast.org/uploadedFiles/Main\\_Site/Content/About\\_Us/Standard\\_Handling\\_Care\\_Surgical\\_Specimens.pdf](http://www.ast.org/uploadedFiles/Main_Site/Content/About_Us/Standard_Handling_Care_Surgical_Specimens.pdf). Accessed January 15, 2014. Updated April 9, 2014.

14. Eikermann M, Velmahos G, Abbara S, et al. Case records of the Massachusetts General Hospital—case 11—2014: a man with traumatic injuries after a bomb explosion at the Boston Marathon [published correction appears in *N Engl J Med*. 2014;370(24):2354]. *N Engl J Med*. 2014;370(15):1441–1451. doi:10.1056/NEJMcpc1314240.