

Brief Research Report

Corresponding author

Andrew J. Eyre, MD
Department of Emergency Medicine
Brigham and Women's Hospital
75 Francis St. Neville House, Suite 236A
Boston, MA 02115, USA
E-mail: aeyre@partners.org

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Point-of-Care Ultrasonography in a Domestic Mass Casualty Incident: The Boston Marathon Experience

Andrew J. Eyre, MD^{*}; Michael B. Stone, MD; Heidi H. Kimberly, MD

Department of Emergency Medicine, Brigham and Women's Hospital, 75 Francis St. Neville House, Suite 236A, Boston, MA 02115, USA

ABSTRACT

Background: The role of Point-of-Care (POC) ultrasonography in domestic Mass Casualty Incidents (MCI) has not been well established. On April 15th, 2013, two improvised explosive devices were detonated near the finish line of the Boston Marathon injuring 264 patients and killing 3. These patients were rapidly stabilized and transported to Boston area hospitals.

Objectives: To examine the role of POC ultrasonography during the Emergency Department response to a large-scale domestic MCI, and to identify successful processes as well as barriers to care delivery in order to best prepare for future events.

Methods: An online survey containing multiple-choice and open-response questions was distributed to Emergency Medicine housestaff, physician assistants, fellows and attending physicians in the Boston area Emergency Departments who cared for patients during the Boston Marathon MCI.

Results: There were 50 respondents from 6 hospitals who were directly involved with patient care. 23 respondents (46%) performed POC ultrasounds during the MCI, but only 8 of these respondents (35%) documented findings in the usual fashion by saving images including patients medical record numbers. Many respondents altered documentation patterns due to lack of patient information/registration data and to time constraints. Focused assessment with sonography in trauma (FAST) exams were reported as the most useful application (96%), followed by lung sliding (36%), and soft tissue/foreign body exams (18%). Respondents noted that POC ultrasound provided clinical information sooner than plain films and computed tomography (CT) scans, as these traditional imaging resources were significantly overwhelmed. Many described the value of POC ultrasound in resource allocation and triage once acute intra-abdominal and thoracic injuries had been excluded. Respondents reported being hindered by too few ultrasound systems or systems with long boot-up times and/or lack of battery power.

Conclusions: Though limited by our retrospective survey-based methodology, our findings indicate that POC ultrasound was utilized in the hospital-based response to a large-scale domestic MCI. POC ultrasound was especially useful given delays in traditional imaging. Our findings highlight the difficulties with normal documentation patterns during such events, and suggest that specific planning for POC ultrasound should be incorporated into future MCI preparedness.

KEYWORDS: Ultrasonography; Mass Casualty Incidents; Disasters.

ABBREVIATIONS: POC: Point-of-Care; MCI: Mass Casualty Incidents; FAST: Focused assessment with sonography in trauma.

INTRODUCTION

The use of Point-of-Care (POC) ultrasonography has been described during the emergency response to Mass Casualty Incidents (MCI) such as natural disasters and military battles.¹⁻⁸ POC ultrasonography plays an increasingly important role in emergency medicine training and patient care.⁹ Additionally, POC ultrasonography has been incorporated into routine trauma management and is considered standard of care.^{10,11} However, the role of POC ultrasonog-

raphy has not been well established during domestic mass casualty incidents such as bombings, shootings, and other attacks targeting civilian populations. Unfortunately, domestic mass casualty incidents, such as bombings and mass shootings, are becoming more common. In recent years and months, the world has witnessed a large number of such man-made mass casualty incidents that have led to significant loss of life and disability. During such events, hospital resources are overwhelmed and it can be difficult or impossible to provide care in the routine, standard fashion. As a low cost, rapid, easily repeatable, focused, and clinician-performed modality, POC ultrasonography offers many characteristics that may be valuable during a domestic mass casualty event.

On April 15th, 2013, two improvised explosive devices were detonated near the finish line of the Boston Marathon in Boston, Massachusetts, USA. As a result of these explosions, 3 patients died at the scene, and an additional 264 patients were injured. These patients were rapidly stabilized and transported to one of several Boston area hospitals within 45 minutes of the explosions.¹²⁻¹³ This mixed-methods study sought to build on personal experience by describing the role that POC ultrasonography played during the Emergency Department response to this large-scale domestic MCI.¹⁴ Additionally, we sought to identify successes and challenges related to the use of POC ultrasonography in this setting, in order to best prepare and train for inevitable future events.

METHODS

We created an 11-question, mixed-methods, and online survey (surveymonkey.com) containing demographic, multiple-choice, and open-response questions. Given the unanticipated nature of the bombing and our desire to limit the time that elapsed from event to survey response, the survey questions were not prospectively validated. A link to the survey was distributed *via* email to all emergency medicine providers, including housestaff (resident physicians), physician assistants, fellows and attending physicians, at the Boston area hospitals who received patients directly from the Boston Marathon MCI, including 2 adult level 1 trauma centers, 2 level 1 adult/level 1 pediatric trauma centers, 1 adult level 1/level 2 pediatric trauma center, 1 level 1

pediatric trauma center, and one academic-affiliate community hospital. Non-emergency medicine providers were not included in the study. After an initial email inviting participation, a second follow-up email was sent ten days later. These emails were distributed by the emergency medicine ultrasound directors of the participating institutions. Only providers who directly cared for patients during the incident were asked to respond. Given the inability to directly target specific providers with the survey, a response rate could not be calculated. The study was reviewed and exempted by the Institutional Review Board (IRB).

RESULTS

There were 50 respondents from 6 hospitals who were directly involved with patient care of victims from the Marathon. 19 respondents (39%) were Emergency Medicine housestaff, 2 (4%) were physician assistants, 1 (2%) was a fellow and 27 (55%) were attending physicians, with one respondent declining to reveal their level of training. See Figure 1 of the 50 respondents, 23 (46%) performed POC ultrasounds during the MCI. Providers reported caring for an average of 4.7 MCI patients (range 1-15) and performing 2.6 ultrasounds (range 1-10) on those patients. While FAST exams were reported as the most useful application (96%), followed by lung sliding (36.4%) for pneumothorax, providers also utilized POC ultrasonography for soft tissue/foreign body exams (18.2%) and vascular access (4.6%). Figure 2.

However, only 8 (35%) of the respondents who utilized POC ultrasonography documented findings in the usual fashion by saving digital images and/or video clips that included patients medical record numbers. Respondents reported altering documentation patterns both due to lack of patient information or registration data and to time constraints. In the open response questions, respondents noted that POC ultrasonography was especially useful given the delay in plain radiography and CT scans. Many respondents described the value of POC ultrasonography in resource allocation and triage once acute intra-abdominal and thoracic injuries had been excluded. Respondents reported being hindered by ultrasound systems with long boot-up times and/or lack of battery power and by having too few ultrasound machines available.

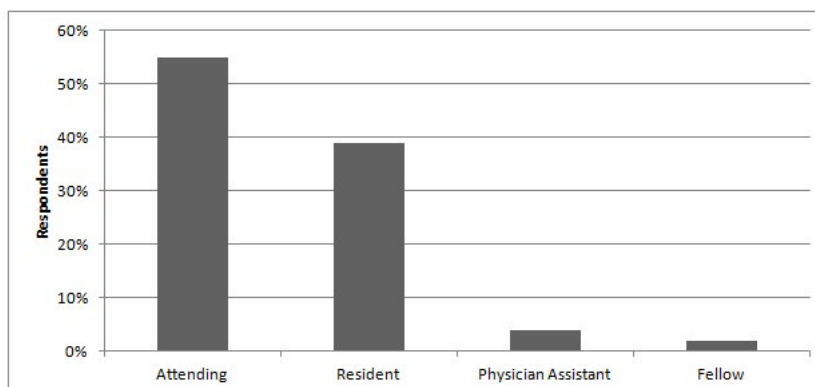


Figure 1: Level of training of survey respondents.

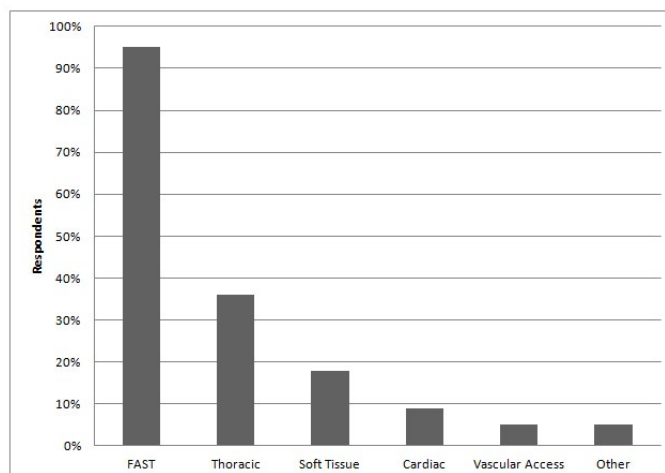


Figure 2: POC ultrasound applications found to be useful.

DISCUSSION

The unpredictable nature of mass casualty incidents makes them difficult to investigate systematically and in a rigorous fashion. Our study, while limited by its retrospective survey design, is one of the few studies to describe the utility and limitations of point-of-care ultrasound during domestic mass casualty events such as bombings, mass shootings, and other man-made disasters. We found that nearly half of respondents reported using POC ultrasonography to assess and treat patients during the hospital-based response to a large-scale domestic MCI. As might be expected in a multi-trauma incident, the most commonly utilized applications included the FAST exam and chest ultrasonography, which allowed providers to quickly assess for life threatening thoracic or abdominal trauma. POC ultrasonography was also utilized to evaluate soft tissues given the multiple shrapnel injuries and for procedural guidance during central venous catheter placement. In addition, we found that POC ultrasonography was utilized by providers at all levels of training.

The anecdotes shared by respondents in the open response questions describe both the utility and challenges of POC ultrasonography during this incident. Traditional radiology imaging resources were overwhelmed during this incident¹⁵ and have been shown to be heavily utilized in other MCIs.⁴ The ability to perform rapid bedside POC ultrasonography provided crucial clinical information early on given significant delays in obtaining plain radiography studies or CT scans due to the large surge of patients. POC ultrasound was also described as a triage tool in patients awaiting CT scans or operative intervention. In some cases, ultrasound was able to exclude significant life threatening injuries allowing expedited operative management for patients with isolated extremity injuries.

While about half of the survey respondents utilized POC ultrasonography, the other half reported their ability to utilize POC ultrasonography was limited by access to ultrasound machines, and delayed machine boot-up times. Some described lack of training or comfort level with ultrasound as a barrier and

others described the scene as too chaotic to incorporate ultrasound. It is possible that given more readily available ultrasound systems specifically targeted to the point-of-care applications (i.e. portable systems with extended battery life and rapid boot up times) ultrasound would have been even more widely utilized during this event.

Another significant challenge cited by survey respondents involved documentation of ultrasound findings. We found that normal documentation patterns of saving digital images and/or video clips that included patients medical record numbers were followed only in a minority of cases. Respondents cited lack of time and unregistered patients as the main barriers to documentation. When ultrasound findings are not recorded and/or documented appropriately, it may hinder the ability to perform serial examinations, communicate findings with other team members, and perform quality assurance. As a result of this incident, our institution revised our unidentified patient registration process and charting protocols. Paper charts that stay with the patient include an area for documentation of the bedside ultrasound. Our experience highlights the importance of incorporating POC ultrasonography use and documentation into MCI and emergency preparedness planning.

This study was designed to describe the role of POC ultrasonography in a domestic MCI, both how it was utilized and the barriers to its effective use in order to assist in preparation for future MCI events. Given the unanticipated nature of such events, our study was retrospective in nature and is limited by its survey-based design. We were unable to calculate a response rate as the survey was sent to all ED providers at the 6 sites although only those who were actively involved in the care of patients were asked to respond. We did not include other departments and it is possible that surgical/trauma services also utilized POC ultrasonography. Given that the majority of ultrasound exams were either not linked to patient medical record numbers or the images were not saved, we were unable to review ultrasound clips to perform quality assurance or evaluate clinical outcomes. Similarly, we did not evaluate participant's level of

experience, certification, or comfort level with POC ultrasonography. Finally, this study is specific to the Boston Marathon MCI where multiple academic medical centers are located, and may not be generalizable to other incidents in other locations. Despite these limitations, this study suggests that POC ultrasonography was utilized during the hospital based response to a large scale domestic MCI. Given the unfortunate increase in urban mass casualty incidents, future investigations evaluating how POC ultrasonography affects clinical care and outcomes during both domestic and international MCI's would be of great benefit. We recommend incorporating POC into disaster preparedness planning.

CONCLUSIONS

In this retrospective survey of emergency providers, we found that POC ultrasound was utilized by almost half of respondents during the hospital-based response to a large-scale domestic MCI, enabling rapid bedside evaluation and triage of multiple patients. Our findings also highlight the barriers to use such as machine specific issues and challenges with normal documentation patterns. Specific planning for POC ultrasound should be incorporated into disaster protocols and preparation.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to disclose.

AUTHOR'S CONTRIBUTIONS

All authors assisted with study design; study materials; data review; and manuscript preparation.

ETHICAL CONSIDERATIONS

This project was approved by the Institutional Review Board (IRB). Participant consent was completion of the survey. No consent is required to publish our article.

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