

Use of Limited Transthoracic Echocardiography in Patients With Traumatic Cardiac Arrest Decreases the Rate of Nontherapeutic Thoracotomy and Hospital Costs

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Abbreviations

LTTE, limited transthoracic echocardiography

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Objectives—Limited transthoracic echocardiography (LTTE) has been introduced as a hemodynamic tool for trauma patients. The aim of this study was to evaluate the utility of LTTE during the evaluation of nonsurviving patients who presented to the trauma bay with traumatic cardiac arrest.

Methods—Approval by the Institutional Review Board was obtained. All nonsurviving patients with traumatic cardiac arrest who reached the trauma bay were evaluated retrospectively for 1 year. Comparisons between groups of patients in whom LTTE was performed as part of the resuscitation effort and those in whom it was not performed were conducted.

Results—From January 2012 to January 2013, 37 patients did not survive traumatic cardiac arrest while in the trauma bay: 14 in the LTTE group and 23 in the non-LTTE group. When comparing the LTTE and non-LTTE groups, both were similar in sex distribution (LTTE, 86% male; non-LTTE, 74% male; $P = .68$), age (34.8 versus 24.1 years; $P = .55$), Injury Severity Score (41.0 versus 38.2; $P = .48$), and percentage of penetrating trauma (21.6% versus 21.7%; $P = .29$). Compared with the non-LTTE group, the LTTE group spent significantly less time in the trauma bay (13.7 versus 37.9 minutes; $P = .01$), received fewer blood products (7.1% versus 31.2%; $P = .789$), and were less likely to undergo nontherapeutic thoracotomy in the emergency department (7.14% versus 39.1%; $P < .05$). The non-LTTE group had a mean of \$3040.50 in hospital costs, compared with the mean for the LTTE group of \$1871.60 ($P = .0054$).

Conclusions—In this study, image-guided resuscitation with LTTE decreased the time in the trauma bay and avoided nontherapeutic thoracotomy in nonsurviving trauma patients. Limited TTE could improve the use of health care resources in patients with traumatic cardiac arrest.

Key Words—cardiac sonography; echocardiography and resuscitation; echocardiography in trauma; echocardiography in traumatic cardiac arrest; emergency ultrasound; limited echocardiography; traumatic cardiac arrest

Traumatic cardiac arrest carries a very high mortality rate.¹⁻⁵ Additionally, an initial rhythm of asystole in such circumstances is associated with a very low probability of survival in cases of both blunt and penetrating traumatic cardiopulmonary

arrest.^{3,4} Accordingly, withholding cardiopulmonary resuscitation in nonsurvivable situations prevents unnecessary use of valuable resources.⁶

Although relying on a pulse examination to reflect cardiac activity has several limitations,⁷ it continues to be the reference standard for guiding the course of therapy during a code situation.⁸ However, the absence of a palpable pulse does not always reflect a lack of cardiac activity, since this perceived “lack of pulse” caused by inefficient cardiac contractions can be a result of reversible conditions such as cardiac tamponade, pulmonary embolism, and pneumothorax.^{9,10}

Cardiac sonography has been successfully used to evaluate patients with nontraumatic cardiac arrest in the emergency department and prehospital arena.^{11–13} Importantly, lack of cardiac activity, known as “standstill heart,” has been associated with a very high positive predictive value of death, whereas the presence of cardiac activity has been associated with survival in patients with traumatic cardiac arrest and those with nontraumatic cardiac arrest.^{12–14}

Limited transthoracic echocardiography (LTTE) has numerous applications in the critical care setting and in the early phase of resuscitation during trauma.^{15–19} The objective of this study was to evaluate the utility of LTTE in patients with nonsurvivable traumatic cardiac arrest, specifically with regard to allocation of resources for treatment of these patients.

Materials and Methods

Institutional Review Board approval was obtained for this retrospective chart review of all patients who arrived to the trauma center without vital signs or who lost vital signs on arrival, developed traumatic cardiac arrest, and did not survive resuscitation efforts between January 2012 and January 2013 (Virginia Commonwealth University Institutional Review Board number HM15419 title).

Comparisons between groups of patients in whom TTE was performed during resuscitation and those in whom it was not performed were conducted. Variables evaluated included age, sex, Injury Severity Score, mechanism of trauma, time spent in the trauma bay, percentage of patients requiring thoracotomy in the emergency department, and administration of blood products. An analysis of the hospital cost and hospital charges was performed by comparing these groups.

The LTTE was performed by trained providers, including emergency physicians, trauma attending surgeons, and residents in both specialties. Limited TTE was

performed during the active cardiopulmonary resuscitation process with chest compressions to assess cardiac function during a 10-second pause for a pulse check.

The goal of LTTE was to assess global cardiac activity as well as reversible causes of a lacking pulse such as cardiac tamponade. It was not intended to evaluate the volume status, wall motion abnormalities, or ventricular size.

For the purpose of evaluating cardiac activity only, the operator was required to obtain a single window. This view could be any of the following: parasternal long, parasternal short, apical, or subxyphoid. After the resuscitation, a written report was placed in the chart regarding the LTTE findings.

For statistical analysis, $P \leq .05$ was considered significant.

Results

During the study period, 37 patients did not survive traumatic cardiac arrest after arriving at our trauma center. Of these 37 patients, 29 lost vital signs before arrival, and the other 8 lost vital signs on arrival to the trauma bay. Of those patients with a witnessed arrest, only 1 underwent LTTE.

The LTTE group included 14 patients, and the non-LTTE group included 23 patients. Comparisons of the LTTE and non-LTTE groups revealed a similar sex distribution (LTTE, 86% male; non-LTTE, 74% male; $P = .68$), age (34.8 versus 24.1 years; $P = .55$), Injury Severity Score (41.0 versus 38.2; $P = .48$), and percentage of penetrating trauma (21.6% versus 21.7%; $P = .29$).

Compared with patients in the non-LTTE group, those in the LTTE group spent significantly less time in the trauma bay (13.7 versus 37.9 minutes; $P = .01$) and were less likely to undergo nontherapeutic thoracotomy in the emergency department (7.14% versus 39.1%; $P = .05$), and although the difference was not statistically significant, the LTTE group received fewer blood products (7.1% versus 31.2%; $P = .0789$).

Regarding hospital costs and charges, the LTTE group had a mean of \$1871.60 in hospital costs compared with \$3040.50 in the non-LTTE group ($P = .0054$). The mean hospital charges for LTTE were \$8282.50, which were statistically significantly lower compared with \$14,182.30 for the non-LTTE group ($P = .0135$). In all of these nonsurviving patients, the LTTE findings showed a standstill heart.

Discussion

The resuscitation of patients presenting with traumatic cardiac arrest, regardless of the mechanism of trauma, entails

a considerable effort and use of resources and has a very low rate of success.⁶ Despite the importance of this issue, there is no consensus regarding how long these resuscitation efforts should be performed.⁶ This study describes a group of patients who lost vital signs during transport or on arrival to the trauma bay and did not survive cardiopulmonary resuscitation. All of these nonsurvivors were noted to have absence of cardiac activity on LTTE.

Echocardiography has been described as a useful tool for evaluating cardiac activity during cardiac arrest in many scenarios, including the prehospital arena.¹³ It allows for the recognition of tamponade as a reversible cause of traumatic cardiac arrest²⁰ and enables assessment of global cardiac function during cardiac arrest.²¹ At our institution, LTTE has been added as a diagnostic adjunct to assess the causes of hypotension in trauma patients.^{16–19} During a cardiac arrest situation, the use of cardiac sonography can provide the needed information to recognize a reversible cause as well as an opportunity to triage patients who have a nonsurvivable injury. The complete lack of cardiac activity or a standstill heart has been associated with a 100% mortality rate in nontraumatic cardiac arrest¹⁴; in trauma situations, the absence of cardiac activity has been found to predict death with a 99% negative predictive value.²² In this study, we evaluated only nonsurvivors who, in concert with previous findings, had a lack of cardiac activity on LTTE.

The subxyphoid window is already part of the focused assessment with sonography for trauma examination.²³ This window provides the opportunity to visualize the 4 cardiac chambers and the pericardium. Focused assessment with sonography for trauma has traditionally been used to identify the presence of a pericardial effusion. Shifting the focus from solely evaluating anatomic data to analyzing the physiologic information that this window provides, such as the volume status, ventricular size, and global cardiac function, could be useful when treating unstable patients.¹⁹

In this study, the use of LTTE resulted in less time spent in the trauma bay. Patients who underwent LTTE also showed a trend toward a significantly decreased need for blood transfusions. Patients who underwent LTTE also required fewer invasive procedures, which translated into decreased use of available resources.

Cardiac sonography has been used in both medical and traumatic cardiac arrest situations.^{10,12,14,21,22,24,25} Lack of cardiac function has been linked to 100% mortality.^{22,25} The use of cardiac sonography should be incorporated into the algorithms for the treatment of patients presenting with traumatic cardiac arrest to ensure higher-quality patient care and better resource allocation.

This study had limitations, including its retrospective nature and its very small number of patients. Repeating the study in a prospective manner on a larger scale is necessary to evaluate the validity of these results.

In conclusion, in this study, LTTE was a useful tool for supporting the clinical decision-making process when treating patients with traumatic cardiac arrest. It resulted in decreased use of available resources in the care of nonsurviving trauma patients.

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