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## Selected Topics: Prehospital Care

# EMERGENCY MEDICAL SERVICES SIMPLE THORACOSTOMY FOR TRAUMATIC CARDIAC ARREST: POSTIMPLEMENTATION EXPERIENCE IN A GROUND-BASED SUBURBAN/RURAL EMERGENCY MEDICAL SERVICES AGENCY

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☐ **Abstract—Background: Tube thoracostomy has long been the standard of care for treatment of tension pneumothorax in the hospital setting yet is uncommon in prehospital care apart from helicopter emergency medical services. Objective: We aimed to evaluate the performance of simple thoracostomy (ST) for patients with traumatic cardiac arrest and suspected tension pneumothorax. Methods: We conducted a retrospective case series of consecutive patients with traumatic cardiac arrest where simple thoracostomy was used during the resuscitation effort. Data were abstracted from our Zoll emergency medical record (Zoll Medical Corp., Chelmsford, MA) for patients who received the procedure between June 1, 2013 and July 1, 2017. We collected general descriptive characteristics, procedural success, presence of air or blood, and outcomes for each patient. Results: During the study period we performed ST on 57 patients. The mean age was 41 years old (range 15–81 years old) and 83% were male. Indications included 40 of 57 (70%) blunt trauma and 17 of 57 (30%) penetrating trauma. The presenting rhythm was pulseless electrical activity 65%, asystole 26%, ventricular tachycardia/fibrillation 4%, and nonrecorded 5%. Eighteen of 57 (32%) had air return, 14 of 57 (25%) return of spontaneous circulation, with 6 of 57 (11%) surviving to 24 h and 4 of 57 (7%) discharged from the hospital neurologically intact. Of the survivors, all were blunt trauma mechanism with initial rhythms of pulseless electrical activity. There were no reported medic injuries. Conclusions: Our data show that properly trained paramedics in ground-based emergency medical services were able to safely and effectively perform ST in patients with traumatic cardiac arrest. We found a significant (32%) presence of pneumothorax in our sample, which supports previously reported high rates in this patient population.** 

☐ **Keywords—EMS; finger thoracostomy; needle decompression; simple thoracostomy; tension pneumothorax**

## INTRODUCTION

Trauma is a common encounter for the emergency medical services (EMS) provider and accounts for the number one cause of death in children and young adults (1). In a large series of trauma cases, chest injuries were thought to contribute to 20–25% of these traumatic deaths (2). Tension pneumothorax (TPT) is a well-described and common complication of blunt and penetrating chest injury, with a prevalence of 5–20% (3–6). Tube thoracostomy has long been the standard for treatment for TPT in the hospital setting yet is uncommon in prehospital care apart from helicopter EMS (HEMS). The majority of experience with prehospital chest tube decompression is from

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Europe or Australasia where there is a preponderance of HEMS physicians who have extensive experience in placing prehospital chest drains (6–9).

Simple thoracostomy (ST) has been used as an adjunct to tube thoracostomy for >2 decades. Deakin et al. first described the procedure for prehospital suspected pneumothorax in 1995 (10). In this series of patients, ST was an effective means for decompression in the prehospital setting. The procedure appeared effective, as demonstrated by little residual pneumothorax and good lung expansion on follow-up radiographs (10).

Our EMS is a suburban/rural non–fire-based 911 system with ~65,000 calls for service annually in an 1100 square mile service area. We have 220 advanced life support medics supported by 900 emergency medicine technician basics from 13 fire departments in our county. In 2015, Escott et al. outlined a novel ST training system for ground-based EMS systems (11). Training consisted of an initial course of didactic instruction and procedural competency using an anesthetized swine model followed by annual skills check offs (11). Herein, we describe our postimplementation experience with ST.

## METHODS

We conducted a retrospective case series of consecutive patients with traumatic cardiac arrest where ST was used during the resuscitation effort. Data were abstracted from our Zoll emergency medical record (Zoll Medical Corp., Chelmsford, MA) using a standardized method for consecutive patients who received the procedure for a 49-month period between June 1, 2013 and July 1, 2017. We collected general descriptive characteristics, procedural success, presence of pneumothorax, return of spontaneous circulation (ROSC), survival, and neurologic outcomes on each patient. We conducted a 2-tailed Fisher exact test comparing patients with ROSC and ROSC with survival to discharge for patients who received ST along with historical control group of 50 patients with needle thoracostomy (NT). This study was approved by our institutional review board.

## RESULTS

During the study period we conducted ST on 57 patients. The mean patient age was 41 years (range 15–81 years) and 82% were male. The indications included 40 of 57 (70%) blunt trauma and 17 of 57 (30%) penetrating. The presenting rhythm was pulseless electrical activity 65%, asystole 26%, ventricular tachycardia/fibrillation 4%, and other/nonrecorded 5%. Forty-three of 57 (75%) procedures were bilateral. Eighteen of 57 patients (32%) had air return, 14 of 57 (25%) had ROSC, with 6 of 57 (11%) surviving to 24 h and 4 of 57 (7%) discharged from the hospital with normal mental status. Of the 4 survivors, all were blunt trauma mechanism with initial rhythms of pulseless electrical activity. In the 14 of 57 patients with ROSC, 11 of 14 (79%) had air return only, 3 of 14 (21%) had blood return only, and 2 of 14 (14%) had both blood and air return documented. Neither air or blood return was documented in 2 of 14 (14%) patients. We found no difference in transport times or rates of procedure performed on scene vs. en route. The average transport time for NT was 15.33 min vs. 17.04 min for ST. The rates of procedures performed on scene vs. during transport were similar for NT and ST (59% and 60%, respectively). There was not a statistically significant difference in those with ROSC (9/50 for NT and 14/57 for ST, respectively; $p = 0.4833$). We observed similar result for those discharged home after ROSC (0/50 for NT and 4/57 for ST; $p = 0.1212$). There were no reported medic injuries.

## DISCUSSION

Tension pneumothorax is a common life-threatening condition and cause of preventable mortality in both blunt and penetrating trauma (3–5). In the United States, prehospital management of suspected tension pneumothorax involves emergent needle decompression; if successful, this procedure demonstrates a substantial return of circulation rate with reported ROSC rates of 25% after the procedure (12). Needle decompression involves placing a standard 14-g, 4.5-cm angiocath into the pleural space using the second intercostal space midclavicular line or fifth intercostal midaxillary line landmarks. This technique may be suboptimal because of body habitus, needle placement, or mechanical factors that obstruct the free egress of air from the pleural space. There are numerous reports of needle decompression failures involving a combination of factors, including obstruction with blood or tissue, kinking of the catheter, and misplaced catheter (13–20).

In NT, size does matter. In a 2013 review of NT in obese patients, investigators found that a 4.6-cm catheter would reach the pleural space in 52.7% of the population, a 5.1-cm catheter would reach it in 64.8%, and a 6.4-cm catheter would reach it in 79% (21). Although the evidence would appear to support the longer is better theory, this must be balanced with the potential for inadvertent injury to underlying vascular structures. There are multiple reports of significant vascular injury with anterior placement in the second interspace midclavicular line approach (22,23). As for placement issues, there is conflicting evidence on whether the anterior second interspace midclavicular or fourth/fifth space anterior midaxillary is optimal. What is clear is that both approaches have significant failure rates and issues related to misplacement and iatrogenic injury (13–24). Given the problematic nature of needle decompression,