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Original Research

Safety and Efficacy of Thoracostomy in the Air Medical Environment

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A B S T R A C T

Objective: The use of thoracostomy to treat tension pneumothorax is a core skill for prehospital providers. Tension pneumothoraces are potentially lethal and are often encountered in the prehospital environment.

Methods: The authors reviewed the prehospital electronic medical records of patients who had undergone finger thoracostomy (FT) or tube thoracostomy (TT) while under the care of air medical crewmembers. Demographic data were obtained along with survival and complications.

Results: During the 90-month data period, 250 patients (18 years of age or older) underwent FT/TT, with a total of 421 procedures performed. The mean age of patients was 44.8 years, with 78.4% being male and 21.6% being female; 98.4% of patients had traumatic injuries. Cardiopulmonary resuscitation was required in 65.2% of patients undergoing FT/TT; 34.8% did not require cardiopulmonary resuscitation. Thirty percent of patients exhibited clinical improvement such as increasing systolic blood pressure, oxygen saturation, improved lung compliance, or a release of blood or air under tension. Patients who experienced complications such as tube dislodgement or empyema made up 3.4% of the cohort.

Conclusion: The results of this study suggest that flight crews can use FT/TT in their practice on patients with actual or potential pneumothoraces with limited complications and generate clinical improvement in a subset of patients.

The use of thoracostomy to treat tension pneumothorax is a core skill for prehospital providers. Tension pneumothorax is uncommon but potentially lethal and is often encountered in less than ideal settings in the prehospital environment.[1] The use of needle thoracostomy (NT) has made its way into the skill sets of most, if not all, advanced life support prehospital providers and even into some intermediate and basic providers' skill sets.[1]

The use of either finger thoracostomy (FT) or tube thoracostomy (TT) has made its way into the practice of flight crews that are mainly composed of physicians, nurses, and paramedics. Tension pneumothorax occurs when air or blood is trapped in the pleural space, causing intrathoracic pressure to rise. This can be aggravated by patients being transported at altitude. Rising pressure can cause the collapse of internal thoracic structures including great vessels, the lungs, heart, and trachea. Patients can exhibit an obstructive-type shock picture coupled with profound dyspnea.[1]

The efficacy of FT/TT over NT has been brought up in the literature. The inability of the needle to actually penetrate the pleural space (eg, becoming kinked, dislodged, or clotted off) is a real possibility.[2,3] FT/TT allows the provider to penetrate the pleural cavity and definitively and quickly address air or blood under tension.

Performing FT/TT in the prehospital/air medical environment can be challenging; it is a complex skill and potentially lifesaving. The goal of this study was to describe the use of FT/TT in this environment and look at efficacy, survival, and complications.

Methods

This was a retrospective chart review of air medical patient records from an electronic medical record system over a 90-month period. Waiver of consent was granted by an internal investigational review board.

Setting

Vanderbilt LifeFlight is an air medical transport organization consisting of 5 rotor wing aircraft and 1 fixed wing aircraft covering

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a 50,000 square mile referral area within TN, KY, and AL. Medical crews consist of either a nurse/nurse team (both dual licensed registered nurse/emergency medical technician or registered nurse/emergency medical technician-paramedic) or a nurse/paramedic team. Roughly 2,300 to 2,500 patients are transported per year. LifeFlight began service in 1984 and is a Commission on Accreditation of Medical Transport Systems–accredited organization.

Protocols

Since the inception of LifeFlight, NT has been part of the flight crew's skill set. In 1996, TT was introduced into the skill set along with the option of performing FT for the patient in extremis. All patients who undergo thoracostomy have their charts reviewed by an internal quality assurance monitor and the medical director for appropriateness and protocol compliance.

The flight crew can perform TT under protocols set forth by the program's medical director. The skill of TT is taught during initial medical crew orientation using mannequins and in a fresh tissue cadaver laboratory. Skills teaching on animal models is also conducted during flight crew orientation. Maintenance and quality improvement oversight of the TT skill set are done via chart review and semiannual competency assessments.

The FT/TT protocol calls for the patient to exhibit 1 or more of the following: evidence of thoracic trauma such as ecchymosis, abrasions, crepitus, diminished/absent breath sounds, penetrating wounds, and/or presence of subcutaneous emphysema. The patient must also have an injury pattern that is consistent with the development of tension pneumothorax such as a penetrating injury or blunt trauma to the thorax. Other clinical findings in the protocol are vital sign or clinical findings indicating severe hypoxia and/or hypotension, especially in the setting of trauma arrest. The protocol calls for FT/TT to be performed on patients with multisystem injury or thoracoabdominal penetrating injury who are in trauma arrest (Table 1).

In general, TT is preferred over NT, especially when NT has been attempted with no improvement in the patient's condition. TT is performed using a #10 blade, Kelly clamp, and 36F chest tube in adults; graduated tube sizes are available for pediatric patients. A vertical incision is performed at the 4th to 5th intercostal space at the mid to anterior axillary line behind the pectoralis muscle. The tube is introduced to lay in the anterior position and sutured in. The tube is connected to a closed seal device. FT is performed the same way, but a tube is not introduced immediately into the pleural cavity. FT serves as a quick and definitive way to address or rule out tension pneumothorax. The same incision can be used later for a tube thoracostomy if the clinician so desires.

Results

Data were extracted from a prehospital electronic medical record database. Inclusion criteria consisted of all patients being transported via LifeFlight who underwent TT or FT. Patients < 18 years of age who received either TT or FT from the flight crew were excluded.

A 90-month period was reviewed from July 2006 to December 2013. During this time, 13,347 adult patients were transported, and 250 patients received TT or FT (1.8%); a total of 421 FTs/TTs were performed.

Data extracted included basic demographic information, mechanism of injury or illness, and type of transport. Type of transport was classified as either a scene transport or interhospital transfer. A scene transport is any transport of a patient who has had a traumatic or medical event and has not been seen in a hospital but was picked up at a nonhospital locale. An interhospital transport is any patient transport that originates in a health care facility. The transport type consisted of 70% scene flights and 30% interhospital. The mean age for the cohort was 44.8 years and ranged from 18 to 89 years of age; men comprised 78% of the group. The cohort was overwhelmingly made up of trauma patients (98%) versus medical patients (2%). The trauma patient group consisted of either a blunt or penetrating-type mechanism; blunt trauma included motor vehicle crashes, falls, and so on and penetrating trauma gunshot and stab wounds. Table 2 summarizes the demographic data for the study group.

Table 1
LifeFlight Indications for Finger/Tube Thoracostomy

- Trauma arrest
- Shock with suspicious or unknown cause
- Shock or low cardiac output state with evidence of thoracic/abdominal trauma
- Shock or low cardiac output state with positive pressure ventilation

Table 2
Demographics of Patients Undergoing Finger/Tube Thoracostomy (N = 250)

Characteristic	Number of Patients	% of Patients
Age		
Age 18-65	222	88.8
> 65	28	11.2
Mean age	44.8	
Sex		
Male	196	78.4
Female	54	21.6
Mechanism of injury/illness		
Trauma	246	98.4
Medical	4	1.6
Trauma		
Blunt	195	78
Penetrating	51	20.4
Gunshot wound	42	16.8
Stab wound	9	3.6
Type of transport		
Interhospital	73	29.2
Scene	177	70.8

Clinical data were also assembled. Patients were divided into 2 groups: individuals who underwent cardiopulmonary resuscitation (CPR) or were without vital signs were placed in 1 group. Patients who had measureable vital signs during the transport were placed in the other group. Survival beyond the initial resuscitation effort in the receiving emergency department was also tabulated; patients who left the resuscitation bay with measurable vital signs, typically to go for further workup or operative intervention, were classified as survivors. Patients who did not leave the resuscitation bay and were pronounced dead were classified as nonsurvivors. Other data points focused on the use of unilateral or bilateral FT/TT, clinical improvement, and complications (Fig. 1).

Within the study group, 163 patients required CPR (65.2%); of that group, 1 (0.58%) patient survived (an adult male with a single stab wound and pericardial tamponade). Of the patients undergoing CPR, 144 (88.3%) of them received either bilateral FT/TT with the goal of treating an actual or potential tension pneumothorax; 19 patients received unilateral FT/TT. All patients in this group were intubated before or during transport.

The remainder of the group (87 patients [34.8%]) did not require CPR. Survival for this group was much higher; 74 patients survived (85% and 29.6% of the total). Of the patients who survived, only 21 (28.3%) received bilateral FT/TT, whereas 53 (71.6%) patients received unilateral FT/TT. A subgroup of patients not requiring CPR did not survive and lost vital signs while in the resuscitation bay; 13 patients (15.0% and 5.2% of total) did not survive and were pronounced dead in the resuscitation bay. Of this group, 77% (67/87) were intubated before or during transport.