The Impact and Description of a Training Program With a Novel Landmark Device for Needle Thoracostomy

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ABSTRACT

Background: Needle thoracostomy (NT) is a lifesaving procedure for patients with tension pneumothorax but requires correct anatomical placement to ensure effectiveness and minimize complications. We describe a novel emergency medical services (EMS) training using a lateral NT landmark device, the SAM ThoraSite, and report provider feedback on the training.

Methods: A 90-minute training was delivered to EMS providers. Providers completed pre- and post-training surveys regarding confidence in procedural performance, concerns about complications, and overall educational experience.

Results: The response rate was 79.4%. Post-training confidence in correctly performing NT increased significantly (7.1 vs 9.0, $P < .001$). Participants also reported higher satisfaction with this training compared with prior needle thoracostomy education (6.9 vs 9.3, $P < .001$).

Discussion: A novel EMS educational session incorporating the ThoraSite landmark device improved provider confidence in NT performance and increased satisfaction with training.

BACKGROUND

In patients with tension pneumothorax, needle thoracostomy (NT) is a potentially lifesaving prehospital procedure. However, this procedure is not without risk. Major iatrogenic complications can occur when NT is placed in an incorrect anatomical location, leading to procedural failure and visceral injury.[1] Advanced Trauma Life Support and Tactical Combat Casualty Care guidelines have begun adopting a lateral chest wall approach – in addition to the traditional anterior approach – for NT, primarily due to military data demonstrating increased procedural efficacy.[2] Thus, the lateral approach is relatively new in civilian emergency medical services (EMS) education and is being utilized with increased frequency, though complication rates remain similar.[1]

Less familiarity with the lateral approach may contribute to complications. The SAM ThoraSite landmark device can assist EMS providers in identifying the correct anatomical location for a lateral NT.[3] This device is a template card placed inferior to a patient's axilla with a window approximating the correct lateral NT site, namely the third to fifth intercostal spaces between the anterior axillary and midaxillary lines.[3] Before instituting a new device, EMS medical directors are responsible for ensuring skills proficiency through the development of guidelines and educational curricula. The objectives of this study were to describe an initial NT landmark device training program developed by EMS medical directors and delivered by paramedic educators to EMS providers. We also assessed changes in EMS providers' perceptions of procedural confidence, potential complications or workflow issues, and educational experience for lateral NT following the training session.

METHODS

Study Design

This study compared self-reported confidence among EMS providers in performing a lateral NT before and after an initial training session using the ThoraSite landmark device (Model Number: TS200-5P-EN, SAM ThoraSite, Portland, Oregon). This was an Institutional Review Board-exempt quality improvement study approved by the Medical College of Wisconsin. SAM Medical Inc provided all ThoraSite devices for initial training and implementa-

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Table 1. Pre- and Post-training Survey Questions

Question Type	Pre-survey Question	Post-survey Question
11-point Likert scale (0 = "not at all confident"; 10 = "extremely confident")	How confident are you in correctly performing a lateral chest wall needle thoracostomy? How confident are you in identifying the correct rib space when performing a lateral chest wall needle thoracostomy? How confident are you in identifying the correct location based off the patient's axillary lines when performing a lateral chest wall needle thoracostomy?	Using the ThoraSite, how confident are you in correctly performing a lateral chest wall needle thoracostomy? Using the ThoraSite, how confident are you in identifying the correct rib space when performing a lateral chest wall needle thoracostomy? Using the ThoraSite, how confident are you in identifying the correct location based off the patient's axillary lines when performing a lateral chest wall needle thoracostomy?
Selectable concerns: 1. Placing the needle in the incorrect anatomic location 2. Not relieving the tension pneumothorax 3. Spending too long trying to identify the correct location 4. Injuring yourself 5. Injuring the patient	What are your concerns when performing a lateral chest wall needle thoracostomy? (check all that apply)	Using the ThoraSite, which procedural concerns are alleviated when performing a lateral chest wall needle thoracostomy? (check all that apply)
Yes/No with free response space for "Yes" selections	Do you currently have any workflow issues with the lateral chest wall needle thoracostomy procedure?	When using the ThoraSite, do you have any workflow issues with the lateral chest wall needle thoracostomy procedure?
11-point Likert scale (0 = "not helpful at all," 10 = "extremely helpful")	In the past, how helpful has your training on lateral chest wall needle thoracostomy been?	Today, how helpful has your training on lateral chest wall needle thoracostomy?

tion for the county-wide EMS system but was not involved in data collection, evaluation, or reporting of results.

Study Population and Protocol

The landmark device training and accompanying confidence surveys were administered to EMS providers in a large, urban, fire-based EMS system. The training involved 44 sessions across 13 fire departments, with variation in the number of providers per session. Authors TE and BW, emergency medicine-trained EMS medical directors, developed a 90-minute training program for EMS providers. SAM Medical Inc reviewed educational materials for accuracy, made minor edits based on their experience and best practices, and provided handouts and educational materials but did not directly participate in training delivery. Trained paramedic educators, under guidance from EMS medical directors, delivered the education to other EMS providers.

The instruction included 45 minutes of didactic teaching on the pathophysiology of tension pneumothorax, indications and contraindications for NT, and a step-by-step process for performing lateral NT using the landmark device as outlined by the developer. This included placement in the axilla with appropriate 45° external rotation of the arm and review of the device skills sheet with procedural steps.

Next, a 45-minute hands-on practical session with the landmark device and a full-sized simulation mannequin with NT capabilities was conducted. Participants were provided identical equipment to their prehospital environment, encouraged to utilize the skills sheet, and given the opportunity to perform the procedure in multiple realistic prehospital scenarios. Finally, participants received device certification by passing a skills test demonstrating correct NT placement on a model using the landmark device and following the steps outlined in the skills sheet.

Pre- and post-training surveys designed by authors TE and BW were administered via Qualtrics at the beginning of and immediately following the training session (Table 1). The surveys utilized an 11-point Likert scale for self-reported confidence regarding specific aspects of NT as well as the overall procedure (0 = "not at all confident," 10 = "extremely confident"). Multiple-choice selections were available regarding procedural concerns with NT (Table 1). Providers could report NT workflow concerns using a free-response space and rated their educational experience with the training. The surveys were pretested with paramedic educators to ensure question clarity, with minor adjustments based on feedback. No changes were made to the surveys during the educational sessions described in this report.

Data Analysis

Results from the pre- and post-training surveys were analyzed to identify changes in performance confidence and educational experience when using the ThoraSite versus without. Surveys were only included in the analysis only if participants completed both surveys. Pre- and post-training groups were compared using paired *t* tests for procedural confidence, with $P < .05$ considered statistically significant. The absolute difference in reported workflow concerns was calculated and broadly categorized.

RESULTS

Five hundred fifty-nine EMS providers were trained over 44 sessions, and 444 EMS providers submitted both surveys (response rate, 79.4% [calculated using the American Association for Public

Opinion Research Response Rate 2 formula]).[4] Results for reported confidence and selected procedural concerns are shown in Table 2. Statistically significant increases were found in all three confidence categories following ThoraSite training. Additionally, 40.1% of providers reported that the ThoraSite training helped alleviate concerns about incorrect NT placement, and 22.8% reported that it helped alleviate concerns about patient injury (Table 2).

Table 2. Providers' Self-Reported Confidences and Concerns Before and After ThoraSite Training

Reported Confidence or Concern	Baseline Without ThoraSite	After Training With ThoraSite	*P* value
Confidence in correctly performing NT	7.1 mean rating	9.0 mean rating	<.001
Confidence in accurately identifying rib space	6.9 mean rating	9.0 mean rating	<.001
Confidence in accurately identifying AP location	6.9 mean rating	9.0 mean rating	<.001
Patient injury concerns	31.3% reporting	22.8% reporting alleviated	
Self-injury concerns	9.1% reporting	8.3% reporting alleviated	
Incorrect placement concerns	52.6% reporting	40.1% reporting alleviated	
Ineffective procedure concerns	33.3% reporting	31.1% reporting alleviated	
Time spent identifying placement concerns	29.2% reporting	29.5% reporting alleviated	

Abbreviations: NT, needle thoracostomy; AP, anterior/posterior location.

Free-text responses described ThoraSite workflow concerns in 14 pre-training surveys and 6 post-training surveys. The most common concerns referenced increased procedure time (n = 2) and insufficient training (n = 2). Other concerns included provider disagreement, anatomical challenges with pediatric use, and device availability (n = 1 for each). Finally, EMS providers reported increased satisfaction ratings with this novel educational session compared with previous NT training (6.9 vs 9.3, $P < .001$).

DISCUSSION

This novel educational experience, created by EMS medical directors and delivered by paramedic educators, demonstrated the clinical potential of landmark devices for improving NT. Proper location identification has been at the forefront of quality improvement research involving NT. Several small studies have shown that providers at all levels often fail to correctly identify the traditional anterior NT site.[5,6] Specifically, patients receiving prehospital NT were at risk of or suffered potentially serious iatrogenic injury from NT placed too medially, thereby entering the mediastinum and its internal structures.[1,7] Lateral NTs can also cause visceral injury to the lung or abdominal organs if placed too inferiorly and may have marked reduced efficacy if placed too anteriorly or posteriorly.[1] A simple landmark device can alleviate provider concerns regarding improper NT placement and potentially reduce complications.

By increasing provider confidence and alleviating procedural concerns, this training session with a landmark device may increase provider willingness to perform NT in appropriate situations. As demonstrated by Lairet et al, NT is not always performed in patients with indications; up to 48% of combat zone casualties with indications for NT did not receive one.[8] While multiple factors contribute to this, Studer et al noted that lack of confidence with NT may play a role in this shortcoming.[9] This training session demonstrated increased confidence in NT placement and diminished concerns among EMS providers. Moreover, the statistical significance of findings is complemented by clinically meaningful significance, as the survey group was large and the increase in confidence substantial, rising from 7.1 to 9.0 on a 0-10 scale.

Previous studies demonstrate that robust paramedic training that is well received by participant positively affects confidence and procedural success. After conducting intensive paramedic airway education sessions, Walker et al reported significant long-term increases in confidence and medical knowledge from a well-received training session.[10] In a follow-up study, Carter et al noted sustained increases in successful procedural performance.[11] Similarly, our cohort demonstrated that a well-received educational session led to increased confidence in NT procedural performance. Pending follow-up studies of long-term retention and successful procedural performance, this study provides a model for EMS medical directors seeking to efficiently implement procedural education with NT landmark technologies.

Despite limited reports of the ThoraSite in the literature, to our knowledge, this product is being actively researched in the emergency medicine communities at the time of publication. Because the product is relatively new, there is little available clinical data. However, the ThoraSite's novelty emphasizes the importance of reporting on a novel training experience when introducing a potentially clinically significant product. Any training session on a particular skill is likely to result in a short-term increase in a provider's perceived confidence in that skill. While this was reflected in this study, the specific confidence elements in NT placement versus not using the device were notable. Additionally, providers indicated that the ThoraSite alleviated concerns regarding incorrect placement (40.1%) and patient injury (22.8%), which were the first and third most-reported concerns in the pre-survey (Table 2) and are major concerns in clinical NT literature.[1] This is particularly meaningful as these providers had all been trained previously on NT without landmark devices and were able to compare that knowledge base with the expanded knowledge and confidence provided by incorporating this device into training.

Importantly, self-reported confidence and one-time training do not necessarily reflect or lead to long-term skill improvement or knowledge acquisition. Additionally, our results do not directly correlate to real-world procedural accuracy. However, our purpose in this report was to describe the feasibility of ThoraSite training

given its potential as a clinically impactful tool. While we do not provide direct evidence for clinical efficacy, our training demonstrates good reception by EMS providers.

Limitations

In addition to those identified above, our study has several limitations, including those inherent to survey-based research. Specific questions had limited responses because only drop-down lists were available, and the length of time between this educational experience and previous NT education was unknown. Additionally, no comparison group received training without landmark devices.

CONCLUSIONS

This 90-minute training developed by EMS medical directors on a novel landmark device for lateral NT increased EMS providers' procedural confidence. The training also reduced provider concerns about patient injury and incorrect needle placement but did not affect concerns about self-injury or procedure effectiveness. Future research should examine long-term procedural confidence in NT, real-world landmark device use among EMS providers, and the landmark device's impact on NT efficacy and safety.

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