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Training for Emergency Department Thoracotomy

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Abstract

Emergency Department Thoracotomy (EDT) is essentially thoracotomy occurring immediately, close to or at the site of injury such as the prehospital setting or the Emergency Department, as an indicated and integral part of the resuscitation process. This thoracotomy involves making an incision into the pleural space of the chest to access organs in the thoracic cavity, for life saving measures and interventions. A conscious decision to source and explore the best possible modes of training for our Emergency Medicine residents and faculty to learn, be familiar and upkeep the skills in performing EDT. This is an example of a critical procedure, which is extremely time dependent and requires prior knowledge and skills training in order to perform it optimally. Our main motivation for sourcing for some form of simulation training in EDT includes:

1. As the procedure is rare and infrequent, the opportunity for real life experiential training and hands-on practice is very limited.

2. As it is a front line skill that needs to be executed in critical time by a trained person, it needs rapid, concise decision and understanding. Deficiency in skills and indecision will waste valuable time which can be life-saving.

3. Due to the split second decision making needed in deciding and performing EDT, prior repeated practice would be essential in order to attain mastery and familiarity with the steps.

4. As EDT is performed at the frontline, the personnel doing it is often not a trained cardiothoracic surgeon or even a surgeon, thus making it necessary to train physicians, even those from non surgical specialities on carrying it out. The decision to perform EDT, wielding a scalpel and repairing injuries in the thoracic cavity can indeed be an intimidating experience and is indeed not a platform for the first timer, without training or experience.

5. EDT involves many steps and also many surgical tools or equipment which needs familiarization with frequent practice, thus making it even more important to have some form of simulated and regular training.

6. This paper discusses how we arrive at a decision to choose the cut-suit model for our residents to train and be familiar with EDT.

Keywords: Emergency department thoracotomy; Blunt chest trauma; Penetrating chest trauma; Signs of life

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Introduction

Emergency Department Thoracotomy (EDT) was first described by a 19th century physiologist, Prof Moritz Schiff. He provided the first description of open cardiac massage and aortic compression for the resuscitation of cardiac arrest in 1874 [1,2]. It was then only in 1896 that Ludwig Rehn performed the first successful thoracotomy, pericardotomy and cardiac wound repair in a young man with a stab wound to the right ventricle [2,3]. Some 100 years on, there have not been any major changes to the procedure, although the indication for performing EDT has remained a topic of active debate and discussion [1,4]. Emergency thoracotomy is essentially thoracotomy occurring immediately, close to or at the site of injury such as the prehospital setting or the Emergency Department, as an indicated and integral part of the resuscitation process. This thoracotomy involves making an incision into the pleural space of the chest to access organs in the thoracic cavity, for life saving measures and interventions [1,2,4].

Why EDT Training?

In the last few years there has been between 2-5 EDT done annually in our Emergency Department. Thus, it was a conscious decision to source and explore the best possible modes of

Figure 1: The cut suit which can be worn by a volunteer or standardised patient.

Figure 2a and b: The thoracic cut suit in use during scenarios, showing the thoracotomy incision.

training for our Emergency Medicine residents and faculty to learn, be familiar and upkeep the skills in performing EDT. The main motivation for sourcing for some form of simulation training in EDT includes:

1. As the procedure is rare and infrequent, the opportunity for real life experiential training and hands-on practice is very limited.

2. As it is a front line skill that needs to be executed in critical time by a trained person, it needs rapid, concise decision and understanding. Deficiency in skills and indecision will waste valuable time which can be life-saving.

3. Due to the split second decision making needed in deciding and performing EDT, prior repeated practice would be essential in order to attain mastery and familiarity with the steps.

4. As EDT is performed at the frontline, the personnel doing it is often not a trained cardiothoracic surgeon or even a surgeon, thus making it necessary to train physicians, even those from non surgical specialities on carrying it out. The decision to perform EDT, wielding a scalpel and repairing injuries in the thoracic cavity can indeed be an intimidating experience and is indeed not a platform for the first timer, without training or experience.

5. EDT involves many steps and also many surgical tools or equipment which needs familiarization with frequent practice, thus making it even more important to have some form of simulated and regular training.

Other modalities for training were also explored. The uses of cadaveric training models are getting harder to come by. Moreover, with time and preservation, the anatomical structures are often unclear and distorted. Simulation manikin such as The Trauma Man does not allow performance of EDT. It was important to find a tool of reasonable cost, which was reusable and allowed repeated use for training. It also had to be realistic and must be able to demonstrate the various steps and anatomy clearly for the learners and practitioners. The deliberate practice offered *via* simulation training was also a consideration, especially in practising low frequency and high acuity clinical events such as EDT [5-7]. The needs of the learner must also be considered and the training environment must enable them to make mistakes and learn from them. The simulated model should also preferably allow for both summative and formative assessment when needed. Standardised and repeated training should also be addressed [6-8]. In considering the best simulation modality, the factors that we had to bear in mind were:

1. The simulation must be able to replicate each step of the procedure as accurately as possible which must include the anatomical layers and structures involved.

2. The organs to be accessed in the thoracic cavity must be realistic e.g., the tactility of the heart. This is because in the actual procedure, the surgeon or operator will rely on tactile senses to detect rupture in the heart muscles for example.

3. The representative components should be reusable and replaceable to enable cost effective use of the simulation model. Their spatial orientation in the thoracic cavity must also be realistic.

4. Consideration of the force and tactile strength involved in the simulation. Knowing that the actual surgical equipment such as the rib spreader will be used, the model or manikin must be able to withstand these tugs, pulls, wear and tear.

5. The simulation model may need to have some static or passive components as well as the more dynamic, mobile components. The later may need to be replaced after a number of practices.

Guidelines and Indications

Besides just knowing how to perform the procedure of EDT, there were other details which are important. The indications and contraindications are important to know as well because when making a decision on performing it. It's really a matter of split seconds, in the first few minutes when the patient arrives at the Emergency Department. Some of this information is theoretical and residents can learn and read them before coming to the face to face session [1,5,7]. The primary indications are often for:

- Haemorrhage control.
- Release of cardiac tamponade.
- Facilitation of open chest passage.
- Exposure of descending aorta for cross-clamping.
- Repair of exsanguinating cardiac or pulmonary injuries.

These indications have evolved and have been debated and some remain controversial. Practice guidelines have been set by several associations and bodies. One example would be that from The Eastern Association (EAST Guidelines), published in 2015. This criteria utilises Signs of Life (SOL), which is defined as a palpable pulse, measurable blood pressure, electrical cardiac activity, pupillary response, spontaneous breathing or purposeful movement of an extremity [9]. On the other hand, the guidelines put forth by the Western Trauma Association (West Guidelines) stratifies patients based on transport time and injury [4,5].

East guidelines [9]

Strong recommendation

- Pulseless with SOL after penetrating thoracic injury.
- Conditional Recommendation.
- Pulseless without SOL after penetrating thoracic injury.
- Pulseless with SOL after penetrating extra-thoracic injury.
- Pulseless without SOL after penetrating extra-thoracic injury.
- Pulseless with SOL after blunt injury.

Recommend against

- Pulseless without SOL after blunt injury.

West guidelines [4,5]

For blunt trauma patients:

- Less than 10 mins of prehospital CPR.

For penetrating trauma patients:

- Less than 15 mins of prehospital CPR.
- Less than 5 mins of prehospital CPR in patients with penetrating trauma to the neck or extremity.

Others

Patient in profound refractory shock, during training it is also important to reinforce the accepted and relative contraindications, depending on the context and also existing guidelines.

The contraindications for EDT include: [4,5,9-15]

- Blunt injury without witnessed cardiac activity (pre-hospital).
- Penetrating abdominal trauma without cardiac activity (pre-hospital).
- Non-traumatic cardiac arrest.
- Severe head injury.
- Severe multisystem injury.
- Improperly trained team.
- Insufficient equipment.

Cut suit (human worn partial task surgical simulator) technology for EDT simulation

Various simulation related training available for EDT were explored to find the most user friendly, repeatedly reusable, cost efficient methodology and tools available. It has to meet all the criteria discussed earlier. Some of the options looked at included using videos which can be watched repeatedly for familiarization. Cadaveric dissection was becoming more challenging to acquire and also the anatomy was often distorted from the preservation process, thus not giving the operator the most realistic "feel" of performing the EDT. The use of anatomical dissection table was also explored to familiarise with the structural arrangements of the thoracic contents. The existing manikins in the market did not allow optimal performance of the step by step procedure, thus even the creation of a manikin with the EDT training capabilities was explored and discussed with specific vendors. Three dimensional printing was too expensive

Figure 3: Neck and chest cut suit for practice of procedures. Here it is chest tube insertion.

Figure 4: Neck cut suit for practice of cricothyrodotomy and tracheostomy.

and the model would not be reusable. From our exploration, it was discovered that the Cut Suit offers a realistic way to simulate the look, feel and smell effects of severe traumatic events on a live human while allowing first responders and physicians to safely perform real procedures on a live human from the point of injury, to treatment enroot and transition of care to surgical intervention. It comprises of a body system which can be put on by a volunteer. The system can be worn even during intensely physical scenarios at the 'point of injury'. It weighs approximately 35 lbs and allows for interaction with a live patient during the emergency assessment and treatment process. The "suit" will contain the anatomically arranged organ, vessels and other related structures to mimic real anatomy. After a person or volunteer applies the cut-suit, clothing, uniform, body arm or and equipment is usable as usual over it. The skin and organs are easily repairable, allowing for multiple uses (Figure 1). In using these cut suits, Interchangeable organs with variable wound patterns or pathology (internal and external haemorrhaging) can also be readily arranged. It is user friendly, with a certain degree of mobility and can be carried to any area or site where training is to be conducted. Over the cut suit itself customizable wounds can be created and modulated to enhance realism in each scenario. (Figure 1, 2a and b) [16,17].

Training

For the training session, a video on EDT was circulated before hand to the residents for their study and viewing. They were also given reading materials on the procedure for them to understand the steps and indications. At the training session, they were shown the video again to refresh and then watched a demonstration of the EDT performed using the cut suit. Then each one of them had hands-on practice to carry out the procedure under direct observation by core faculty. At the end of the session, each resident completed the questionnaire below with 5 questions:

Questionnaire

1. Did the cut-suit training meet your learning needs? Yes/No/Unsure

2. Was the cut-suit training what you had expected before attending the session? Yes/No. State reasons.

3. What did you like about the training using cut-suit? Free text response

4. Which form of learning (watching the video versus cut-suit training) did you prefer and why?

5. Rate your level of confidence in performing EDT after:

a. Watching the video

b. Going through the cut-suit training

(Grade your confidence level from 1-5, 1 being the least confident and 5 as very confident) A total of 30 Emergency Medicine residents attended the training session.

Discussion

The results of the questionnaire were as follows:

Question 1

All 30 residents (100%) responded "Yes"

Question 2

21 (70%) residents did not expect they would be getting hands-on training and use of the cut suit. They thought the video would be the mode of teaching EDT. 9 residents expected some form of model for training but did not expect a comprehensive model such as the cut-suit, demonstrating all the anatomical details.

Question 3

The free-text responses included:

- The hands-on practice it offered.
- Ability to visualise the exact anatomy as it would be necessary to understand this when doing EDT.
- The model allowed step by step follow though of the procedure.
- Residents can get the "real feel' almost of doing EDT, thus the realistic experience was positive.

The setting up of this EDT training allowed the residents to familiarise themselves with the surgical equipment to be used as well e.g., the rib spreader, as these are not the usual instruments they are exposed to.

Question 4

All 30 (100%) residents preferred the cut suit training to the video. Many of the reasons given were similar to Question 3 above. Other reasons given were the ability to repeat the procedure again and again until they felt comfortable and confident with the recommended steps.

Question 5

5a. For the video method, all 30 residents graded their level of confidence as either 1,2 or 3.

5b. For the use of cut suit training, 50% rated their confidence level at 4/5 and the other 50% chose 3/5 as their level of confidence.

The questions administered to the residents at the end of the session were planned along the lines of Kirkpatrick's model of learning evaluation. Questions 1 and 2 are targeted at Level 1 evaluation i.e., The Reaction (measures reaction to the training) of the residents. Questions 3 to 5 are targeted to address Level 2 evaluation i.e., The Learning (measures understanding of the training). As this is a first time and first session of introducing the cut-suit training, Levels 3 and 4 will only be assessed later on and in the clinical context of practice in the ED. Certainly, each subsequent level of evaluation will provide us with more detailed input of the training methodology and this is with a view to modify or customise further as needed in future [18]. From the training session conducted using the cut-suit, the residents were provided with individualised and realistic hands-on experience. The scenario, responses and interventions, with action feedback, were useful as a form of experiential learning. The answers to the 5 questions showed the positive responses and impact on the residents with only the first session. This would thus prompt us to use the cut suit technology to train residents for EDT, a rarely done procedure in the ED [19-24]. There were also cut suit models available for other skills training e.g., Cricothyrodotomy and chest tube insertion (Figure 3 and 4).

Conclusion

We must continue to explore ways to teach and learn the rare and less commonly encountered procedures and processes in the ED. Skills and knowledge upkeep is important to ensure we give every single patient the best chance of a meaningful survival. Guidelines aren't meant to replace clinical judgment but rather to augment the decision-making process. As with much of medicine, there's always a need for more and better data, and this set of recommendations is no exception. The decision to perform an ED thoracotomy depends heavily on the institutional setting and the downstream resources available to the emergency physician.

Permission

Permission to use the photos has been granted by Strategic Operations. Strategic Operations cut suit® which is distributed worldwide by CAE.

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