INNOVATIONS

Realistic Chest Tube Simulator Using Pork Belly with Skin

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Submitted: May 29, 2017; Accepted: June 18, 2017; Electronically Published: July 14, 2017; https://doi.org/10.21980/J8R03J

ABSTRACT:

Audience: The pork belly chest tube simulator is designed to instruct Emergency Medicine residents and Emergency Medicine-bound students.

Introduction: Chest tube insertion is an essential procedural skill that must be mastered by practicing emergency and surgical providers. It is a lifesaving procedure indicated in cases of pneumothorax, hemothorax, chylothorax, empyema, esophageal/gastric rupture into the pleural space, and traumatic arrest.[1,2] These critical patients require immediate decompression and evacuation of pleural space pathology. Therefore, chest tube insertion must be performed competently and expeditiously to prevent further morbidity and mortality. Performed improperly, chest tube placement can lead to ineffective decompression as well as life threatening visceral and vascular injury. Overall complications rates have been quoted up to 37%.[3,4] Simulation offers a safe and effective method to master such procedural techniques. Unfortunately, many chest tube simulators are expensive[5] or do not offer a realistic simulation experience. Therefore, we have designed an economical device that has a life-like feel, very similar to human skin and tissue.

Objective: The purpose of this model is to teach residents and students how to competently perform and properly secure a surgical chest tube.

Methods: This chest tube simulator uses a piece of pork belly that includes skin with underlying muscle and fascia. This tissue is placed over wooden strips and foam tape which are a proxy for human ribs and pleura. This chest wall anatomy allows the learner to locate landmarks, palpate intercostal spaces on real skin, and perform blunt dissection with a realistic "pop" of pleural tissue. Finally, since chest tube dislodgment is a common and unfortunate cause of morbidity and mortality, this chest wall design allows the learner to practice the essential and various techniques of securing the chest tube to real skin.

Topics: Chest tube, thoracostomy, pneumothorax, hemothorax, empyema, simulation.

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Learner Audience:
Medical Students, Interns, Junior Residents, Senior Residents

Time Required for Implementation:
Preparation: approximately 20 minutes
Didactics: learners will spend about 10 minutes describing the procedure and 10 minutes using this innovation
Learners per instructor: 3:1

Topics:
Chest tube, thoracostomy, pneumothorax, hemothorax, empyema, simulation.

Objectives:
By the end of this instructional session learners should:

1. Discuss the indications, contraindications, and complications associated with chest tube thoracostomy
2. Competently perform chest tube insertion on a simulator
3. Properly secure chest tube

Linked objectives, methods and results:

- Learners are expected to come to this session prepared with pre-reading and instructional videos on the procedure
- Learner will provide indications, contraindications, and complications of this procedure and then proceed to explain and demonstrate the performance of the procedure
- Faculty directly observe learners performing the procedure and provide real time feedback

Recommended pre-reading for instructor:

- Dev SP, Nascimiento Jr. B, Simone C, Chien V. Chest-tube insertion. *N Engl J Med.* 2007; 357:15. doi: 10.1056/NEJMvcm071974.
- Sethuraman K, Duong D, Mehta S, et al. Complications of tube thoracostomy placement in the emergency department. *J Emerg Med*. 2008;40(1):14-20. doi: 10.1016/j.jemermed.2008.06.033
- Kirsch T and Sax J. Tube thoracostomy. In: Robert JR, Custalow CB, Thomsen TW, et al. eds. *Robert and Hedges Clinical Procedures in Emergency Medicine. 6th edition*. Philadelphia, PA: Elsevier; 2014:189-211.

Learner responsible content (LRC):

- Dev SP, Nascimiento Jr. B, Simone C, Chien V. Chest tube insertion. *N Engl J Med.* 2007; 357:15. doi: 10.1056/NEJMvcm071974.
- Sethuraman K, Duong D, Mehta S, et al. Complications of tube thoracostomy placement in the emergency department. *J Emerg Med*. 2008;40(1):14-20. doi: 10.1016/j.jemermed.2008.06.033
- Kirsch T and Sax J. Tube thoracostomy. In: Robert JR, Custalow CB, Thomsen TW, et al. eds. *Robert and Hedges Clinical Procedures in Emergency Medicine. 6th edition*. Philadelphia, PA: Elsevier; 2014:189-211.
- Nickson C. Own the chest tube. Life in the Fastlane Web site. www.lifeinthefastlane.com/own-the-chest-tube. Published April 28, 2011. Accessed June 30, 2017.

Implementation Methods:

- This model is best used in small group session with faculty to learner ratio of 3:1
- Learners are assessed on knowledge and comfort of performing thoracostomy
- Faculty facilitates discussion on indications, contraindications, and complications of the procedure
- Faculty demonstrates procedure on simulator
- Faculty observes learners performing procedure providing real time feedback
- Students are reassessed on knowledge and comfort of performing thoracostomy

List of items required to replicate this innovation:

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1. Sterilite 6 qt. (13 5/8” x 8 ¼” x 4 7/8”) plastic storage container with lid purchased from home improvement store ($0.98 per box with lid)
2. ¾”x 3/4” x 8’ piece of pine purchased from home improvement store ($7.68)
3. Liquid nail adhesive purchased from home improvement store ($ 2.78)
4. 1 roll 3M microfoam tape purchased online ($ 5.00 per roll). Alternate choice is duct tape from home improvement center ($3.98 per roll)
5. 1 roll of stretch wrap purchased from home improvement store (7.99 per roll). 3M Loban Surgical dressing is a costly but superior product available online ($9.35 per drape)
6. Pork Belly with skin still attached cut into 6” by 5” pieces about 1” thick, purchased from local meat market ($3.79 per pound)
7. Clorox household bleach solution or disinfecting wipes for cleaning of reusable apparatus
8. Mannequin head and torso with blue surgical drapes (OPTIONAL)

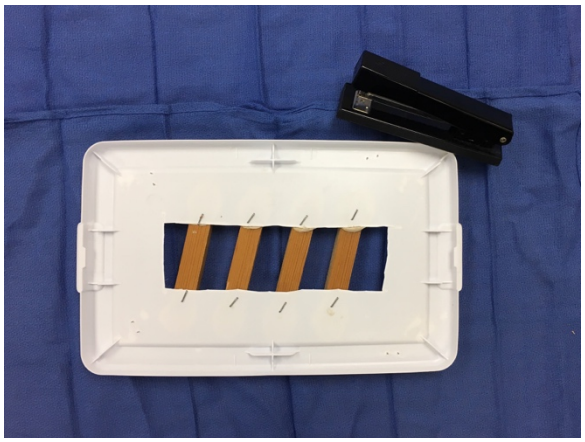
Approximate cost of items to create this innovation:
$7-$10 per trainer

Detailed methods to construct this innovation:

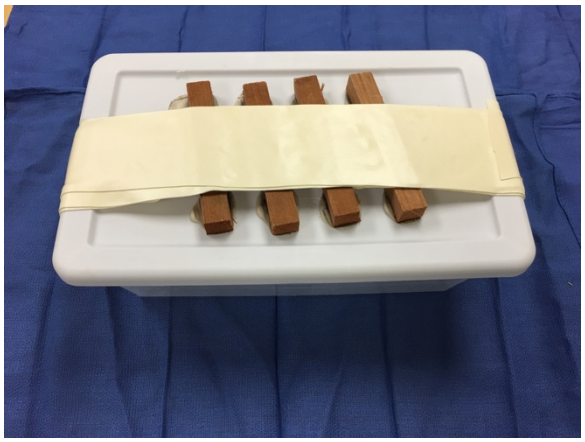
1. Cut 2” by 6” rectangular hole in lid of plastic container.

2. Cut the ¾” pine into 5” pieces with hand saw.

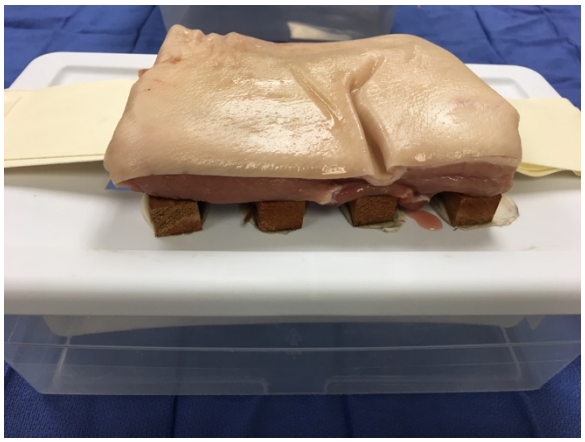
3. Glue ribs (pine pieces) to lid at an 80-degree angle leaving 3/4-1” spaces (for added strength, staple wooden strips at underside of lid and leave to dry overnight).



4. Apply 3M microfoam tape over top of ribs, dipping into the intercostal spaces.



5. Place pork belly over top of ribs.



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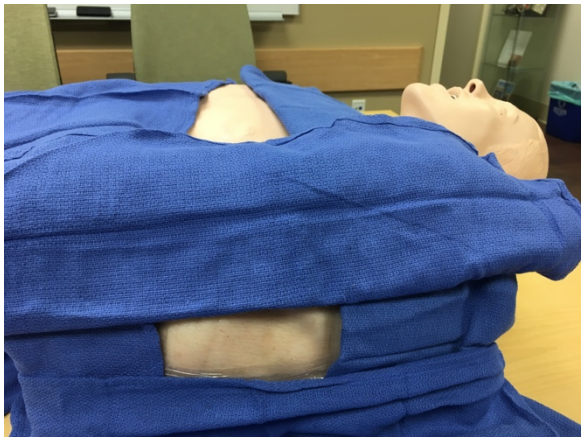
6. Secure pork belly with stretch wrap, applying generously in a spiral fashion from right to left along the length of the box and then right to left along the width of the box. (Alternative: use 3M Loban surgical wrap to secure pork belly to ribs and box, if available.)

7. Incise a rectangular window in the stretch wrap to expose pork skin.

8. Secure apparatus adjacent to mannequin torso with tape.

9. Cover apparatus with blue drapes.



10. Locate 5th interspace. Make a 3-4 cm incision parallel to the rib.

Mebust D P, et al. Realistic Chest Tube Simulator Using Pork Belly with Skin. JETem 2017. 2(3):I16-21.
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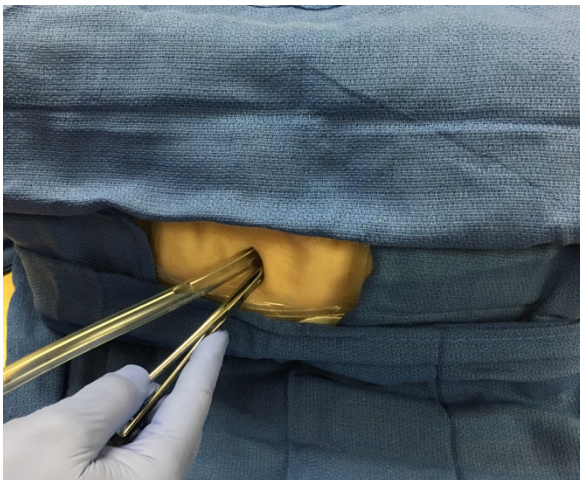
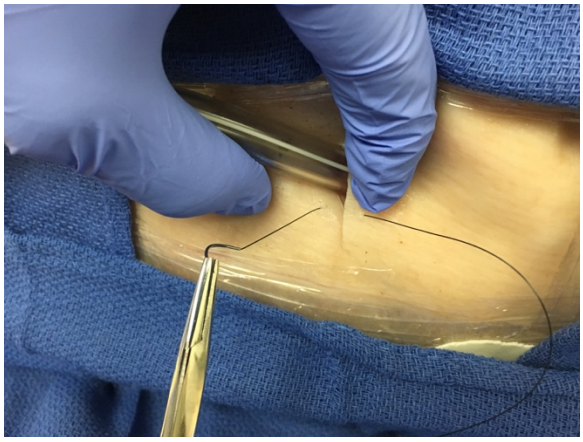
11. Insert curved Kelly forceps into wound and perform blunt dissection. Slide over rib to the next interspace and then puncture pleural lining.

12. After digital palpation, insert 36F chest tube with assistance of curved Kelly clamp.



13. Suture wound and secure chest tube.



14. At completion of task, discard the pork belly and disinfect trainer with liquid bleach or disinfection wipes for reuse, if desired.

Results and tips for successful implementation:
This exercise was implemented with small groups with a learner to faculty ratio of 3:1. There are three interspaces on each model, which would allow three attempts per trainer. For a more realistic experience, the trainer was secured to a mannequin head and torso with tape and covered with blue surgical drapes. The trainer was aligned with the nipple line of mannequin to reinforce landmark identification.

This trainer has been used in conjunction with airway labs with residents and students. Post session feedback has been overwhelmingly positive. Participants report that the utilization of the pork belly provides a realistic experience and affords them the opportunity to practice securing the chest tube (a major weakness of most of respondents). Participants noted a significant increase in post-procedural comfort and confidence with placing chest tubes.

References/suggestions for further reading:

1. Dev SP, Nascimiento Jr. B, Simone C, Chien V. Chest-tube insertion. N Engl J Med. 2007; 357:15. doi: 10.1056/NEJMvcm071974.
2. Kirsch T and Sax J. Tube thoracostomy. In: Robert JR, Custalow CB, Thomsen TW, et al. eds. *Robert and Hedges Clinical Procedures in Emergency Medicine. 6th edition*. Philadelphia, PA: Elsevier; 2014:189-211.
3. Sethuraman K, Duong D, Mehta S, et al. Complications of tube thoracostomy placement in the emergency department. *J Emerg Med*. 2008;40(1):14-20. doi: 10.1016/j.jemermed.2008.06.033
4. Kwiatt K, Tarbox A, Seamon M, et al. Thoracostomy tubes: A comprehensive review of complications and related topics. *Int J Crit Illn Inj Sci.* 2014;4(2):143-155. doi: 10.4103/2229-5151.134182
5. 3B Scientific website. Chest Drain Simulator. https://www.a3bs.com/chest-drain-simulator-w19356-cdt100,p_1455_4227.html. Accessed June 28, 2017.