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Realistic and Inexpensive Ultrasound Guided Paracentesis Simulator Using Pork Belly with Skin

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ABSTRACT:

Audience: The pork belly paracentesis simulator is designed to instruct emergency medicine (EM) residents and emergency medicine-bound students.

Introduction: Abdominal paracentesis is a common procedure done in the emergency department (ED) that must be mastered by EM residents and students. The purpose of a paracentesis is to remove accumulating ascites from the peritoneum. Diagnostic paracentesis is indicated with new cases of ascites or to detect the presence of infection in patients with already known or suspected ascites.¹ Therapeutic paracentesis is often conducted in the ED setting to relieve any cardiorespiratory and gastrointestinal manifestations of tense ascites.² While this procedure has been described in modern medical literature for over a hundred years, the addition of ultrasound can enhance the safety of the procedure and can help detect as little as 100 ml of fluid.³

Objectives: By the end of this instructional session learners should be able to: 1) Discuss the indications, contraindications, and complications associated with abdominal paracentesis; and 2) competently perform an ultrasound-guided abdominal paracentesis on a simulator and remove fluid.

Methods: This paracentesis simulator uses a porcine skin with underlying muscle and fascia to replicate the feel of human tissue undergoing this procedure. A gallon water jug is used to simulate the peritoneal cavity filled with ascites. Placing a small hand towel or sterile blue towel in the water jug acts as a wonderful mimic of bowel loops “floating” in the peritoneal fluid when ultrasound is used. A layer of ultrasound gel is placed liberally on one side of the water jug, and then the pork belly is layered on top of that. This tissue is secured to the jug with 3M microfoam surgical tape (or other adhesive-like duct tape). This model has a realistic feel and can be used with ultrasound to replicate intraperitoneal contents. The thickness of the

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plastic jug will give a realistic “pop” into the peritoneum with the paracentesis needle. Also, this trainer can be used multiple times by different learners before being replaced. This model will allow the learner to conduct a realistic paracentesis procedure while removing actual fluid.

Topics: Paracentesis, ascites, ultrasound-guided procedure, simulation.



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Learner Audience:

Medical Students, Interns, Junior Residents, Senior Residents

Time Required for Implementation:

Preparation: Approximately 5 minutes to assemble each simulator

Didactics: Learners will spend about 5 minutes describing the procedure

Learners will spend 5-10 minutes using this innovation

Recommended Number of Learners per Instructor: 3:1

Approximate cost of items to create this innovation: \$5-10

Topics:

Paracentesis, ascites, ultrasound-guided procedure, simulation.

Objectives:

By the end of this instructional session learners should be able to:

1. Discuss the indications, contraindications, and complications associated with abdominal paracentesis
2. Competently perform an ultrasound-guided abdominal paracentesis on a simulator and remove fluid

- Runyon MS, Marx JA. Peritoneal procedures. In: Robert JR, Custalow CB, Thomsen TW, Hedges JR, eds. *Robert and Hedges Clinical Procedures in Emergency Medicine*. 6th ed. Philadelphia, PA: Elsevier; 2014:852-872.
- Thomsen TW, Shaffer RW, While B, Setnik GS. Videos in clinical medicine. Paracentesis. *N Engl J Med*. 2006; e21:355. doi: 10.1056/NEJMvcm062234.

Learner responsible content (LRC):

- Witting MD. Gastrointestinal procedures and devices. In: Tintinalli JE, Stapczynski J, Ma O, Yealy DM, Meckler GD, Cline DM, eds. *Tintinalli's Emergency Medicine: A Comprehensive Study Guide*. 8th ed. New York, NY; McGraw-Hill; 2016:563-566.
- Runyon MS, Marx JA. Peritoneal procedures. In: Robert JR, Custalow CB, Thomsen TW, Hedges JR, eds. *Robert and Hedges Clinical Procedures in Emergency Medicine*. 6th ed. Philadelphia, PA: Elsevier; 2014:852-872.
- Thomsen TW, Shaffer RW, While B, Setnik GS. Videos in clinical medicine. Paracentesis. *N Engl J Med*. 2006;e21:355. doi: 10.1056/NEJMvcm062234

Implementation Methods:

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

List of items required to replicate this innovation:

1. 1-gallon jug of water (\$1 from a local grocery store)
2. Sterile blue towel or hand towel
3. Pork Belly with skin still attached, about a 15 cm x 15 cm piece (\$5 from Asian market or local meat market)
4. Ultrasound and ultrasound gel (OPTIONAL)
5. Roll of 3M Microfoam Surgical tape (or duct tape, \$3-4 from local hardware supply store)
6. Mannequin head and torso with blue surgical drapes (OPTIONAL)
7. Paracentesis kit

Approximate cost of items to create this innovation: \$5-10

Linked objectives and methods:

- Learners are expected to come to this session prepared—having completed the pre-reading and instructional videos on the procedure
- The learner will provide indications, contraindications, and complications of this procedure and then proceed to explain the procedure (objective 1)
- The learner will be able to perform the procedure on the task trainer (objective 2)
- Faculty directly observe learners performing the procedure and provide real-time feedback

Recommended pre-reading for instructor:

- Witting MD. Gastrointestinal procedures and devices. In: Tintinalli JE, Stapczynski J, Ma O, Yealy DM, Meckler GD, Cline DM, eds. *Tintinalli's Emergency Medicine: A Comprehensive Study Guide*. 8th ed. New York, NY; McGraw-Hill; 2016:563-566.



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Detailed methods to construct this innovation:

Materials:



1. Open gallon water jug and place blue sterile towel into the jug. May need to pour some of the water out so the towel does not displace the water inside and make a mess. Next, top off the jug by adding more water to completely fill it to eliminate any air pockets that will interfere with the ultrasound images.



2. If the cap is not a screw-on type, then tape cap shut. Allow gravity to bring the towel to bottom of the water jug.



3. Apply a liberal amount of ultrasound gel to one side of the water jug.



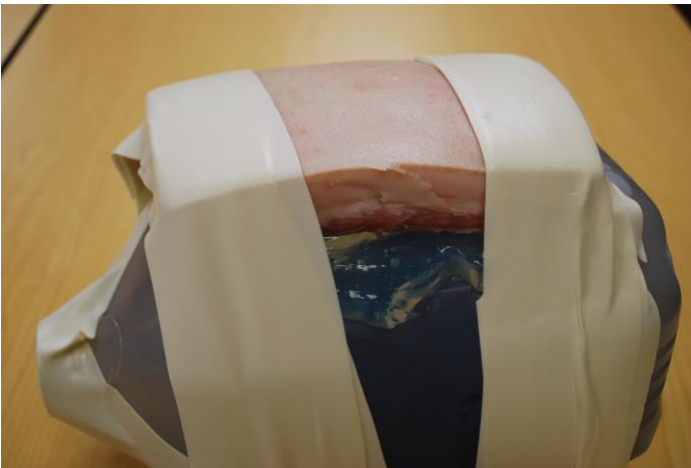


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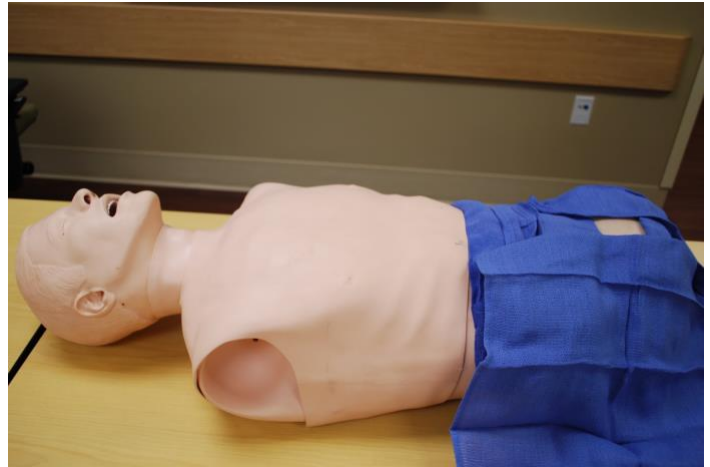
4. Layer a piece of pork belly on top of the ultrasound gel.



5. Secure piece of pork belly to water jug with 3M Microfoam Surgical tape or duct tape.



6. Place the apparatus adjacent to a mannequin torso and secure with tape (optional). Then cover the apparatus with blue drapes for a more realistic effect.

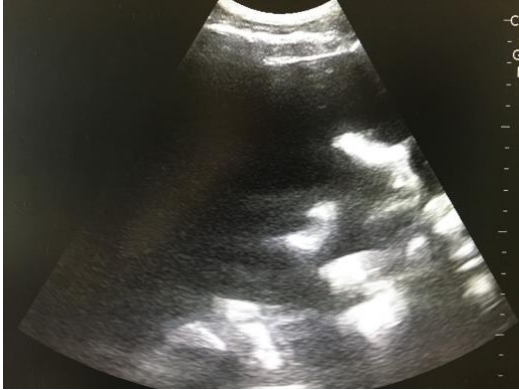


7. The simulation model is ready. The learner can use ultrasound to confirm the presence of ascites and loops of intestines by placing a curvilinear ultrasound probe on the pork belly.





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8. They can then use a paracentesis kit to practice drawing out peritoneal fluid. There will be a realistic feel to the needle insertion into actual skin and tissue and a realistic “pop” into the peritoneal cavity.



Results and tips for successful implementation:

This exercise was implemented with small groups, with a learner to faculty ratio of 3:1. Each trainer will have room for multiple attempts by different learners before needing to be replaced. You may be required to add more water to the jug between attempts by different learners. For a more realistic experience, the trainer was secured to a mannequin head and torso with tape and covered with blue surgical drapes.

This trainer has been utilized during procedure labs for residents and students. Feedback has been overwhelmingly positive. Participants reported that the pork belly skin and tissue, the ability to use ultrasound to visualize bowel loops,

and the realistic “pop” into the peritoneal cavity made this simple and inexpensive simulator extremely realistic.

References/suggestions for further reading:

1. Yu AS, Hu KQ. Management of ascites. *Clin Liver Dis.* 2001; 5(2):541-568. doi: 10.1016/S1089-3261(05)70177-X
2. Arroyo V, Ginès P, Planas R. Treatment of ascites in cirrhosis. Diuretics, peritoneovenous shunt, and large-volume paracentesis. *Gastroenterol Clin North Am.* 1992; 21(1):237-256.
3. McGahan JP, Anderson MW, Walter JP. Portable real-time sonographic and needle guidance systems for aspiration and drainage. *AJR Am J Roentgenol.* 1986;147(6):1241-1246. doi: 10.2214/ajr.147.6.1241