An Easy-to-Make, Low-Cost Ultrasound Phantom for Simulation Training in Abscess Identification and Aspiration

Juliana Wilson, DO, MPH, Lorraine Ng, MD, Vaughn Browne, MD, PhD, Resa E. Lewiss, MD

We have created a low-cost and easy to make phantom for abscess identification using point-of-care ultrasound. The phantom also allows needle tracking and abscess aspiration using ultrasound guidance.

Key Words—abscess phantom; point-of-care ultrasound; simulation

Received April 28, 2016, from the Department of Emergency Medicine, Associated Faculty Emergency Medicine, University of Colorado School of Medicine, Aurora, Colorado USA (J.W., V.B., R.E.L.); and Columbia University Medical Center (CUMC), New York-Presbyterian/Morgan Stanley Children's Hospital of New York, New York USA (L.N.). Revised manuscript accepted for publication August 19, 2016.

Address correspondence to Juliana Wilson, DO, MPH, Department of Emergency Medicine, Associated Faculty Emergency Medicine, University of Colorado School of Medicine, 5600 S Quebec St, #312A, Greenwood Village, CO 80111 USA.

E-mail: julianaewilson@gmail.com

Abbreviations

ED, emergency department; POCUS, point-of-care ultrasound; SSTI, skin and soft tissue infections

doi:10.7863/ultra.16.04077

Emergency department (ED) visits for skin and soft tissue infections (SSTI) are increasing at a rate higher than overall ED visits.[1,2] It is estimated that there were 34.8 million ambulatory visits for SSTI between 2006 and 2010.[2]

Distinguishing between cellulitis and abscess based on physical examination alone can be challenging even for the most skilled health care provider. The inability to correctly identify a SSTI can lead to delayed treatment or unnecessary and potentially harmful procedures.[3–7] When using ultrasound to evaluate SSTI, it has been shown that clinicians change their management up to 50% of the time.[8] Studies have shown that using point-of-care ultrasound (POCUS) can identify abscesses with greater sensitivity (97.5% versus 78.7%) and specificity (69.2% versus 66.7%) when compared with physical examination alone.[4,5,8] Identifying the correct SSTI guides appropriate treatment and improves patient outcomes.[5,8]

Live models with pathology may not always be available for teaching, so a phantom is a cost-effective and time-efficient way to simulate and teach POCUS for SSTI. Various methods to create simulators for training can be expensive and difficult for trainees to access.[9] In this paper, we describe how to make a low-cost, easily reproducible phantom for the ultrasound identification of abscess that allows for the practice of needle guidance and abscess aspiration.

Materials and Methods

Previous articles have described methods for creating skin and soft tissue phantoms using gelatin.[10] In addition to using the methods previously described,[10] in this phantom model we were able to create distinct abscess-like structures, which allowed for the aspiration of simulated purulent material. Materials needed for the construction of the phantom are pictured in Figure 1 and listed in the Appendix. To

create the abscess, we used 12-inch red balloons. The balloons were filled with tapioca or vanilla pudding using a 5 cc syringe (Figure 2). Two or three ccs of olive oil was added to each balloon to decrease viscosity and increase ease of aspiration. Once the balloons were filled, all of the remaining air was removed from the balloons before tying them off. The balloons were then secured to the bottom of a large opaque red bin using Gorilla Glue (Gorilla Glue Co, Cincinnati, OH) or rubber cement (Figure 3). It is necessary to secure the balloons so that they do not rise to the top of the hot gelatin mixture. The secured balloons were then allowed to dry for 4 to 6 hours. We found that the use of a red opaque container, red balloons, and cherry Jell-O (Kraft Foods, Le Roy, NY) created an opaque simulation model. Trainees were consequently not able to identify the abscess based on visual examination alone.

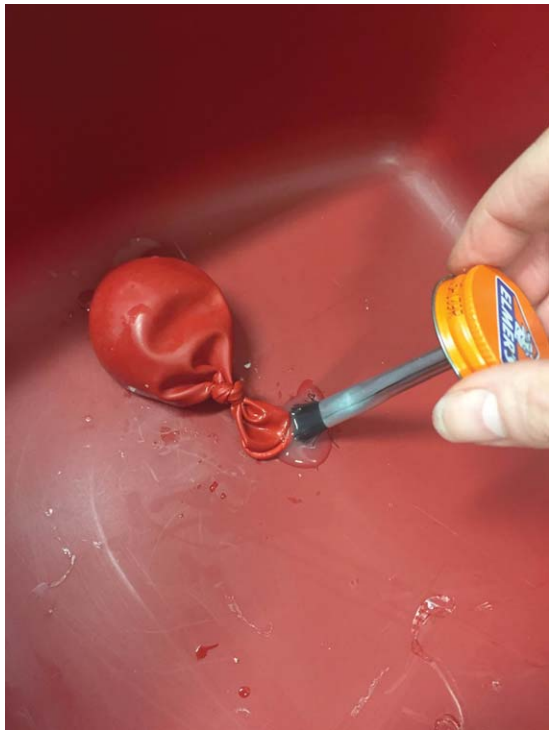
After the balloons dried, we used the methods described previously with cherry-flavored sugar-free Jell-O and sugar-free psyllium hydrophilic mucilloid fiber (sugar-free Metamucil [The Procter & Gamble Co, Cincinnati, OH]) to create simulated soft tissue that completely surrounds the secured balloons.[10] Using this method, we used 6 ounces of sugar-free cherry flavored Jell-O and 3 tablespoons of sugar-free Metamucil. Care must be taken to whisk vigorously when the ingredients are combined with the boiling water to limit precipitation. The phantom was chilled in the refrigerator for 4 to 6 hours before use. Once completed, the trainees were able to scan the phantom, track needle tips, and aspirate the balloon contents multiple times (Figures 4–7). F4-F7

The phantom was kept in its container and refrigerated when not in use. If refrigerated, it can be kept in good condition for several weeks. In our experience, even after many attempts at needle aspiration, the

Figure 1. Phantom materials: fiber powder, olive oil, cherry-flavored sugar-free Jell-O, tapioca pudding, 5-cc syringe, rubber cement, red balloons, and red plastic container.

Figure 2. Technique used to fill balloons with pudding. Inject tapioca pudding using a 5-cc syringe.

Figure 3. Securing the balloons with rubber cement to ensure that they do not float to the top of the liquid gelatin mixture.



phantom remained in good condition without significant needle track artifacts, and allowed for reuse. The material within the balloons can be aspirated and reinjected to allow for multiple attempts at aspiration.

Figure 4. Ultrasound scanning of the phantom using a linear transducer. Notice the opacity of the phantom, which obscures the identification of the abscess by direct visualization.

Figure 5. After the model has set, aspiration of purulent material with an 18-gauge needle on a syringe.

Results

As described previously, it is possible to make a low-cost and easy-to-make ultrasound phantom to simulate abs-

Figure 6. Ultrasound image of a phantom abscess using a high-frequency transducer.

Figure 7. Needle tip and tracking within the abscess phantom. This image is after several aspiration attempts and demonstrates the abscence of needle track artifacts with multiple uses.

cesses, and the aspiration of abscess-like material can be produced for training purposes.

Discussion

Point-of-care ultrasound helps to distinguish an abscess from cellulitis in SSTI.[4,7,8] Pathologic examples can often be difficult to simulate in the training environments. The phantom described in this article can be made from low-cost, easily accessible materials and reproduced for training purposes to produce abscess-like structures in soft tissue, and to practice eye-hand coordination in needle tracking and aspiration. We have used this model during small group training sessions with students, residents, and practicing physicians with good success. As described previously, one of the unique aspects of this model is that it allows for opacity with visual inspection, provides an excellent POCUS image, and the pudding simulates purulent material when aspirated.

It has been shown that when learners are provided a safe training environment to practice identifying pathology and procedures using POCUS, it allows for increased confidence and success in the clinical practice environment.[11] For these reasons, it is important to have a low-cost and easily reproducible simulation model to help train health care professionals in abscess identification and aspiration.

Appendix

Abscess Phantom Ingredients

Cherry-flavored, sugar-free Jell-O
Sugar-free psyllium hydrophilic mucilloid fiber (sugar-free Metamucil)
12-inch balloons (4–5)
5-cc syringes
Tapioca or vanilla pudding
Opaque container
Olive oil
Gorilla Glue or rubber cement

References

1. Taira BR, Singer AJ, Thode HC Jr, Lee CC. National epidemiology of cutaneous abscesses: 1996 to 2005. *Am J Emerg Med* 2009; 27: 289–292.
2. May L, Mullins P, Pines J. Demographic and treatment patterns for infections in ambulatory settings in the United States, 2006–2010. *Acad Emerg Med* 2014; 21:17–24.
3. Bacon E, Tabbot M. When a peritonsillar abscess is not a peritonsillar abscess: using bedside emergency ultrasound to change the diagnosis. *Am J Emerg Med* 2016; 34:1186.e5–e7.
4. Iverson K, Haritos D, Thomas R, Kannikeswaran N. The effect of bedside ultrasound on diagnosis and management of soft tissue infections in a pediatric ED. *Am J Emerg Med* 2012; 30:1347–1351.
5. Adhikari S, Blaivas M. Sonography first for subcutaneous abscess and cellulitis evaluation. *J Ultrasound Med* 2012; 31:1509–1512.
6. Marin JR, Dean AJ, Bilker WB, Panebianco NL, Brown N, Alpern ER. Emergency ultrasound-assisted examination of skin and soft tissue infections in the pediatric emergency department. *Acad Emerg Med* 2013; 20:545–553.
7. Blaivas M, Adhikari S. Unexpected findings on point-of-care superficial ultrasound imaging before incision and drainage. *J Ultrasound Med* 2011; 30:1425–1430.
8. Tayal V, Hasan N, Norton J, Tomaszewski C. The effect of soft-tissue ultrasound onthe management of cellulitis in the emergency department. *Acad Emerg Med* 2006; 13:384–388.
9. Scott GM, Fung K, Roth KE. Novel high-fidelity peritonsillar abscess simulator. *Otolaryngol Head Neck Surg* 2016; 154:634–637.
10. Lo M, Ackley SH, Solari P. Homemade ultrasound phantom for teaching identification of superficial soft tissue abscess. *Emerg Med J* 2011; 29:738–741.
11. Evans LV, Dodge KL, Shah TD, Kaplan LJ, Siegel MD, Moore CL, Hamann CJ, Lin Z, D'Onofrio G. Simulation training in central venous catheter insertion: improved performance in clinical practice. *Acad Med* 2010; 85:1462–1469.