A New Simulation Model for Skin Abscess Identification and Management

Jason D. Heiner, MD

Introduction: Cutaneous abscesses are common, and emergency physicians in training must develop competency with abscess identification and management through incision and drainage. Although simulation models can enable proficiency in such skills, current abscess models described in the literature suffer from limitations. The author presents a novel abscess management training simulator evaluated by physicians.
Methods: An artificial abscess wall tunneled near the surface of a chicken breast is injected with mock purulent material to create the simulator. Twenty physicians familiar with abscess identification and management assessed the model. The educational value of the model and its sonographic fidelity were evaluated via closed-ended questions and open-ended feedback.
Results: All 20 physician evaluators agreed that an abscess simulator model would be a useful teaching tool and that this particular abscess model would be a useful teaching tool. The evaluators' found the model to realistically simulate a real abscess, but cited the lack of purulent loculations as a potential limitation. When responding to the statement "the ultrasound image of the simulated abscess appears realistic," all physicians either "strongly agreed" or "agreed" with the statement (n = 20).
Discussion: This new simulation model may be an effective tool to teach skin abscess management. Physicians who evaluated the simulated abscess found that it replicates the classic palpable fluctuance and ultrasound findings of an actual abscess, and it can be surgically incised and drained in a similar fashion. Although physicians agreed that this model would be useful, future studies may validate this task trainer as an effective teaching tool.
(*Sim Healthcare* 5:238–241, 2010)

Key Words: Abscess, Drainage, Procedure, Training, Emergency medicine, Medical simulation, Ultrasound.

Cutaneous abscesses account for approximately 1% to 2% of all emergency department (ED) visits, and the incidence of ED visits for such skin and soft tissue infections seems to be increasing during the past decade.[1,2] Abscess identification and the curative procedure of incision and drainage is an important skill for which physicians in training must gain competence. With simulation models, medical students and residents can learn and practice skills before performing procedures on actual patients. Some abscess simulators have been described but suffer from inadequacies related to practicality or fidelity.[3,4] This study describes an abscess model and its evaluation by physicians regarding its realism and potential as an effective teaching tool.

From the Department of Emergency Medicine, Madigan Army Medical Center, Fort Lewis, WA.

Additional material related to this article can be found at http://links.lww.com/SIH.

Address correspondence to: Jason Heiner, MD, Department of Emergency Medicine, Madigan Army Medical Center, 9040 Fitzsimmons Avenue, Fort Lewis, WA 98431 (e-mail: jasonheiner@hotmail.com).

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.simulationinhealthcare.com).

DOI: 10.1097/SIH.0b013e3181d87f0f

METHODS

Model Construction

The primary components of this abscess model are the mock purulence, the simulated abscess wall, and the chicken breast (with skin intact) that contains the simulated abscess (see Video, Supplemental Digital Content 1, http://links.lww.com/SIH/A7). The simulated purulent material is prepared by mixing one part of maple syrup with four parts of mayonnaise (Fig. 1). The simulated abscess wall is composed of a small balloon that is deflated around an 18 gauge catheter (Fig. 2). With a small needle holder (or similar tool) a tunnel is created from the underside of the chicken breast toward the surface with care to avoid penetrating the skin on the opposite side. Near the surface of the top side of the chicken breast, the tips of the needle driver are spread to create a cavity to be filled later by the expanding simulated abscess wall.

The simulated abscess wall is carefully placed in the chicken breast and then expanded with approximately 5 mL of the mock purulent mixture (Fig. 3). A properly expanding balloon is felt with a hand placed on the top side of the chicken breast. If significant resistance is met, the balloon or catheter may be kinked or folded and the unit should be pulled back slightly and then readvanced. Alternatively, the cavity that the balloon is attempting to fill may not be large enough. If this is suspected, the balloon is withdrawn

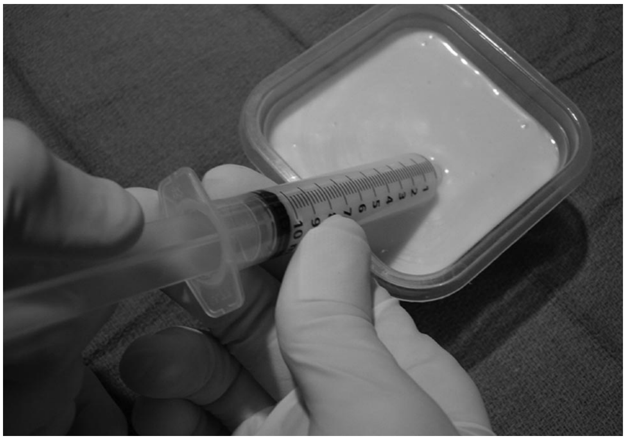

Figure 1. The mock purulence mixture of one part maple syrup with 4 parts mayonnaise is drawn into a 10 mL syringe and set aside for use in later steps.

with the catheter inside and a larger cavity is created by reinserting the needle driver and spreading the tips (as previously described) before attempting expansion of the balloon again. When the balloon is sufficiently expanded with mock purulence, the catheter is removed and the filled simulated abscess remains in place.

The completed model may be refrigerated to ensure freshness or used immediately to practice abscess identification and management. Palpation of the model to identify the area of fluctuance and subsequent incision and drainage can be performed as usual (Fig. 4). Additionally, sonography of the model may be performed to practice the ultrasound identification of an abscess. By varying the depth of balloon placement, the ability to rely on palpation alone to identify the simulated abscess may be adjusted. If desired, the skin may also be moulaged with red makeup to simulate the erythema that often overlies a physiologic abscess.

Model Evaluation

This study was granted exemption from continuing review by our study site institutional review board and the need for informed consent was waived. This model was presented to a convenience sample of 20 emergency medicine physicians (staff and residents) at a 3-year academic emergency medicine training program located at Madigan Army Medical Center in Fort Lewis, WA. All physicians assessing the model were familiar with abscess identification by physical examination and ultrasound and were skilled at surgically managing an abscess. The physician evaluators routinely used ultrasound in areas, such as the examination of soft tissues for abscess and foreign body detection, to assist in the placement of central venous catheters and to identify the presence of abdominal aortic aneurysms and intrauterine pregnancies. Participants were provided with a PowerPoint demonstration of the production of the model and the tools needed to perform the steps of abscess incision and drainage. After examining the model, the physicians anonymously evaluated the educational value of the model using a five-point Likert scale and had the opportunity to provide open-ended comments. Twenty physicians were then presented with unblinded sonographic images of two actual abscesses

Figure 2. To prepare the abscess wall, the knot of a small inflated balloon is first penetrated by an 18 gauge angiocatheter (top image). The needle from the angiocatheter is then withdrawn, allowing the air to escape as the balloon deflates around the catheter (bottom image).

and a sonographic image of the abscess model (Fig. 5). They then anonymously evaluated the sonographic fidelity of the ultrasound model via a five-point Likert scale.

RESULTS

The 20 physicians who evaluated this model responded positively to closed-ended questions regarding this model. All 20 physicians agreed with both the following statement: "an abscess simulator model would be a useful teaching tool" and "this particular abscess model would be a useful teaching tool." When responding to the statement "the ultrasound image of the simulated abscess appears realistic," all physicians either "strongly agreed" or "agreed" with the statement ($n = 20$). Open-ended feedback revealed two recurring comments: (1) the overall realism of the model was excellent ($n = 12$) and (2) the absence of purulent loculations was a limitation ($n = 5$). One reviewer commented that the lack of palpable warmth was a limitation to the realism of the model.

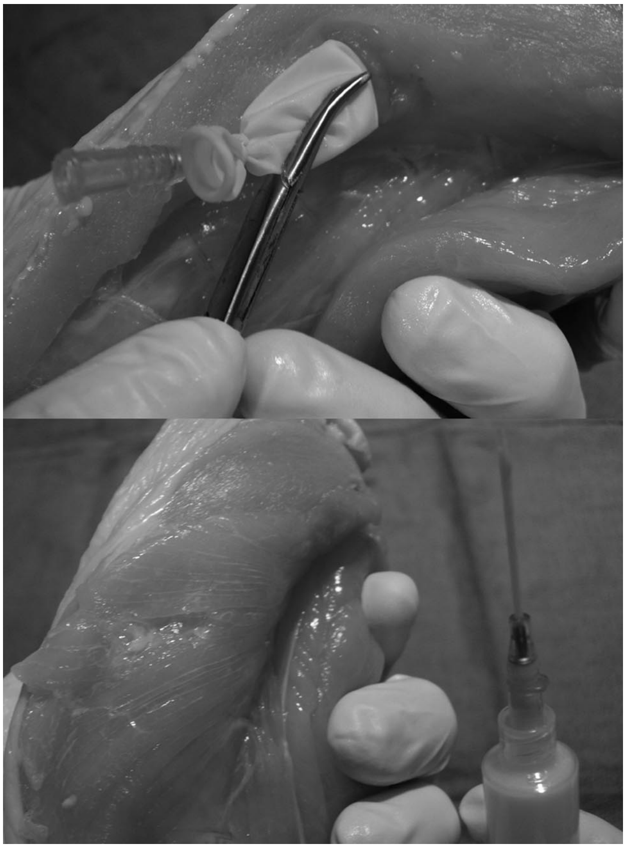

Figure 3. The unfilled artificial abscess is inserted by grasping the tip of the balloon with the catheter inside and gently guiding this unit through the track previously created (top image). After the balloon is expanded with mock purulence, the catheter is removed, leaving the artificial abscess in place (bottom image).

DISCUSSION

This model for skin abscess identification and management has the potential to be a useful and a practical way to simulate a common clinical entity and a procedural skill in emergency medicine. This model is inexpensive to create and all its components can be easily obtained. A recently described skin abscess model relies on a cadaver for abscess implantation.[4] Cadaveric tissue has obvious limitations in-

Figure 4. Abscess incision and drainage may be performed as usual.

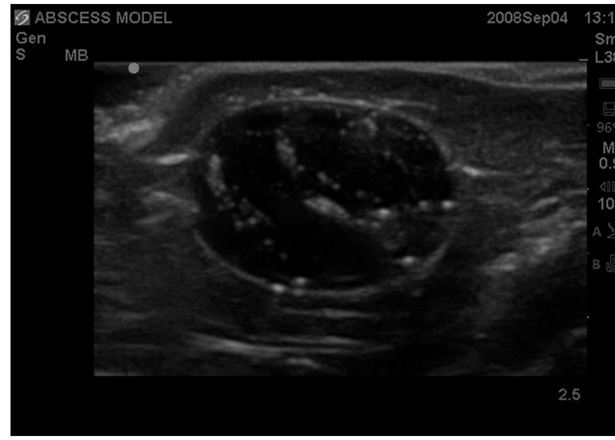

Figure 5. The sonographic appearance of the mock abscess.

cluding cost and availability. The average expense of a cadaver (including the cost of procurement, transportation, and cremation) is >$1000.[5] In contrast, the overall cost of this trainer for all materials is <$4 per model when more than five are made at a time, and the angiocatheter (angiocatheter cost range: $4–$7) is reused for each model. The author finds that these models are simple to create, and after minimal practice a single model can be constructed in <5 minutes after all the materials have been gathered.

This simulated abscess has a degree of fluctuance that can replicate the tactile identification of an abscess as well as its sonographic appearance. The mock purulent material has a consistency similar to real purulence and, by the method described in this article, will stay localized within an artificial abscess cavity until surgically released. Bedside ultrasound has become a useful tool in the ED management of abscesses that are not always obvious on physical examination alone. One ED study of patients with soft-tissue infection with cellulitis but without obvious abscess found that soft-tissue ultrasound changed physician management in approximately half of these patients by identifying or eliminating the presence of a drainable suppurative focus.[6] An abscess is typically not difficult to detect on ultrasound. An abscess has a characteristic sonographic appearance of a mass that is totally or partially anechoic and may be outlined by an echogenic rim or demonstrates the presence of gas.[7] The mock purulent focus of this model seems to reproduce the sonographic appearance of an abscess well, thus offering a valuable opportunity for training in the ultrasound identification of abscesses (Fig. 5). Postprocedure ultrasound of the model can ensure that the abscess has been evacuated.

Like all trainers, this model has limitations. As identified by the physicians who evaluated this model, it lacks the presence of purulent loculations that are often present in physiologic abscesses. It is possible that this limitation may in part be overcome by inserting multiple artificial abscesses in close proximity. All steps of abscess management can be approximated with this model, such as administration of local anesthetic, cavity evacuation, and wound packing. However, areas of realism are lacking in some steps. For example, the tissue will not blanch as would be seen in a live patient when epinephrine is included in the anesthetic block and no feedback from a patient regarding anesthetic effectiveness is possible. The palpable warmth that is also often found is absent from this model. Maple syrup and mayonnaise were chosen to simulate purulence via a trial and error process to find a mixture that adequately simulated the texture and consistency of purulence and maintained this feature even when refrigerated. Similarly, the tissue base was selected for its natural realism. The realism provided by both the organic tissue base and the mock purulence creates a limitation due to its perishable nature.

Some limitations of this study should also be noted. Physicians engaged in a PowerPoint-guided discussion demonstrating the steps of preparing the model but did not directly examine the ease of model preparation by creating their own model. The physicians who evaluated the model were provided with the tools to complete the procedures of abscess incision and drainage as well as wound evacuation and packing. Although they were given enough time to feel that they had adequately evaluated the trainer, the physicians were all not directly observed to ensure that they all completed each step. When evaluating the sonographic fidelity of this abscess model, the 20 physician evaluators were not blinded as to which sonographic image was of the simulated abscess. Although all the physician reviewers agreed that the simulated abscess seemed realistic based on the sonographic image, more robust conclusions could have been made if a blinded study found no difference in selection of the simulated abscess image from the real abscess images. However, the goal of this trainer was to adequately simulate an actual soft tissue abscess for educational value and not necessarily to perfectly simulate the sonographic appearance of an abscess. Although all 20 reviewers overwhelmingly agreed on positive statements regarding the model, future studies or reviews with additional evaluators beyond this technical report may further characterize this model with more confidence.

This new simulation model may be an effective tool to teach skin abscess management. Such task trainers have the utility of teaching baseline competence before performing procedures on patients. They may also be used to evaluate changes in procedural competence over time. Physicians who evaluated the simulated abscess found that it replicates the classic palpable fluctuance and ultrasound findings of an actual abscess, and it can be surgically incised and drained in a similar fashion. Although physicians agreed that this model would be useful, future studies may validate this task trainer as an effective teaching tool.

ACKNOWLEDGMENT

The views expressed herein are solely those of the author and do not represent the official views of the Department of Defense or Army Medical Department.

REFERENCES

1. Pallin DJ, Egan DJ, Pelletier AJ, et al. Increased US emergency department visits for skin and soft tissue infections, and changes in antibiotic choices, during the emergence of community-associated methicillin-resistant *Staphylococcus aureus*. *Ann Emerg Med* 2008;51:291–298.
2. Butler KH. Incision and drainage. In: Roberts JR, Hedges JR, eds. *Clinical Procedures in Emergency Medicine.* 4th ed. Philadelphia, PA: Saunders; 2004:717.
3. Cole FL, Ramirez E, Mickanin J. Skill station models for teaching incision and drainage of abscesses, felons, and paronychia to emergency nurse practitioners. *J Emerg Nurs* 1998;24:455–456.
4. Fitch MT, Manthey DE, McGinnis HD, et al. A skin abscess model for teaching incision and drainage procedures. *BMC Med Educ* 2008;8:38.
5. Mattingly GE, Barnes CE. Teaching human anatomy in physical therapy education in the United States: A survey. *Phys Ther* 1994;8:720–727.
6. Tayal VS, Hasan N, Norton HJ, et al. The effect of soft-tissue ultrasound on the management of cellulitis in the emergency department. *Acad Emerg Med* 2006;13:384–388.
7. Loyer EM, DuBrow RA, David CL, et al. Imaging of superficial soft-tissue infections: Sonographic findings in cases of cellulitis and abscess. *AJR Am J Roentgenol* 1996;166:149–152.

