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Innovations in Simulation

Development of a Subcutaneous Abscess Simulator for Incision and Drainage

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Abstract

Background: Proper incision and drainage of a subcutaneous abscess is a vital skill to develop during physician assistant and nurse practitioner training. Skin and soft-tissue infections, including subcutaneous abscesses, are among the most common complaints seen in primary care. Improper technique may result in bacteremia, septicemia, osteomyelitis, and/or tissue necrosis. Although abscess incision and drainage is taught to a multitude of providers during procedural training courses, finding a safe, inexpensive abscess simulator has been challenging.

Method: A simple, cost-effective subcutaneous abscess simulator was developed using synthetic, skin-like rubber sheets and other common materials. The assembly of this simulator and recruitment for peer evaluation is described.

Results: The simulators were successfully implemented among 17 medical providers with the cost per simulator being less than two dollars each. Simulator assessment by 10 physician assistants and seven physicians found this task simulator to realistically represent the procedure of subcutaneous abscess incision and drainage.

Conclusion: Cost-effective, creative, and innovative use of educator-developed simulators need to be considered for providing realism in clinical skill practice and assessment.

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Community-associated methicillin-resistant *Staphylococcus aureus* has emerged as one of the most common causes of skin and soft-tissue infections (SSTIs) seen in both community and health care settings. Although the microbiology has changed over time, there continues to be an upward trend in incidence of skin and soft tissue infections (Mistry et al., 2014). There has been a three-fold increase in SSTI visit rates in US emergency departments (Esposito, Noviello, & Leone, 2016).

Advanced practice practitioners are often responsible for treating SSTI which may include incision and drainage (I&D). Clinical training may not provide the student with the opportunity to practice this procedure, thus simulation must be incorporated into the didactic curriculum.

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Clinical task trainers are used in a majority of physician assistant and nurse practitioner programs across the United States for skill development. Task trainers provide a safe and realistic model for students to use in the early stages of their education. Students are able to repeatedly practice an invasive skill to help them gain confidence and competence. Simulation provides the opportunity for both immersive and experiential practice for procedures that typically fell under the dangerous "see one, do one, teach one" tradition (Aggarwal et al., 2010). Simulation techniques have enhanced skills and bridged the gap between novice and competent health care professionals. It has allowed for assessment of competency in school and in the professional setting (Galloway, 2010).

Key Points

- A simple, cost-effective subcutaneous abscess simulator was developed using synthetic, skin-like rubber sheets and other common materials.
- The low-cost simulators were successfully evaluated by 17 medical providers.
- Survey data revealed all participants found the simulator realistically represented the procedure of subcutaneous abscess incision and drainage.

Finding cost-effective, realistic, and safe models for students to practice subcutaneous abscess incision and drainage was challenging. One of the most life-like simulations published uses a pudding mixture injected into cadaveric tissue to perform I&D (Fitch, Manthey, McGinnis, Nicks, & Pariyadath, 2008). Lo, et al. (2012) created soft-tissue abscesses using a Jell-O, Metamucil, and water mixture injected into cadavers to create hyperechoic peritonsillar spaces to be viewed by bedside ultrasound and then incised and drained. Similarly, Scott et al. created a high-fidelity peritonsillar abscess using a latex glove filled with vanilla pudding and tied off with suture and imbedded into a peritonsillar space in a transected cadaver neck. Although the use of human skin is most ideal for I&D, the cost and availability of and specialized storage of cadavers may not be a reality for teaching institutions. Denadai, Hossnew, and Martinhao Souto (2013) described the use of chicken skin for cutaneous surgical procedures due to its echotexture and similarity to human tissue. While fiscally responsible, this task training model has the potential for safety issues due to the need for specific storage of chicken and the risk for salmonella. They identified the rigorous supervision required for them to reduce the risk of infection. Heiner (2010) also used chicken skin pocketed with 5 mL of maple syrup and mayonnaise injected into a balloon to simulate purulence within an abscess wall. Although physicians (n = 20) were able to palpate, locate sonographically, I&D the abscess, and comment on its teaching potential, it required refrigeration and special care. Lack of palpable warmth was a limitation in the model evaluation. Augenstein, Yoshida, Lo, and Solari (2016) created an abscess model using paintballs imbedded into cylindrical precooked packaged polenta at different depths so students could identify abscesses sonographically and incise and drain. They note that there were no low-cost models for abscess simulation and have created a task trainer requiring no refrigeration or special handling that can be remolded and used repeatedly. Although abscess simulators are commercially available, no formal evaluation or review exists to validate their merit. In addition, most are single use and 30 USD per pad.

With priority being patient safety, it makes sense to have cost-effective task simulators, especially for invasive procedures. In a survey conducted by Beer and Stoehr (2015), interest and utilization of task simulators has been popular in physician assistant education according to a Web-based survey to physician assistant program directors across the United States. Out of the 63 responding physician assistant programs, 88.3% of them utilize task trainers with the majority of use being in the didactic phase of training. It is also an active learning strategy commonly used in nurse practitioner programs to increase skill and confidence (Pittman, 2012, p.516). The lack of multiuse, commercially available SSTI models for I&D was the impetus for the authors to develop a subcutaneous abscess task simulator for incision and drainage.

Methods

Construction of the subcutaneous abscess task simulator (SATS) was performed by physician assistant program faculty. The subcutaneous tissue was created using Tattoo World™ tattoo practice skin sheets. A mixture of 1 mL Ben Nye™ synthetic blood gel, three drops of yellow food-coloring, and even parts pudding and mayonnaise were placed into a 60 mL syringe. Approximately 5 mL of the mixture was injected into a small balloon to simulate the purulent material within an abscess. The balloons were tied off manually. A full 60-mL syringe filled approximately 12 to 15 balloons. Three balloon abscess constructs were placed into an 8-inch section of a hollowed Styrofoam swim noodle, covered with the synthetic skin and secured with sealing tape. The underside of the swim noodle was leveled by slicing a flat surface for stability. The top of each synthetic skin sheet covering the balloon was dusted with inexpensive pink cosmetic blush to simulate erythema (Figures 1–3). Each of these items was inexpensive and readily available from amazon.com (Table).

The goals of the simulation model were to

- simulate the appearance of an SSTI
- have a palpable abscess
- be able to be incised and drained.

Physicians, physician assistants, nurse practitioners, and physician assistant faculty from a hospital emergency department and a northeastern US university were asked to

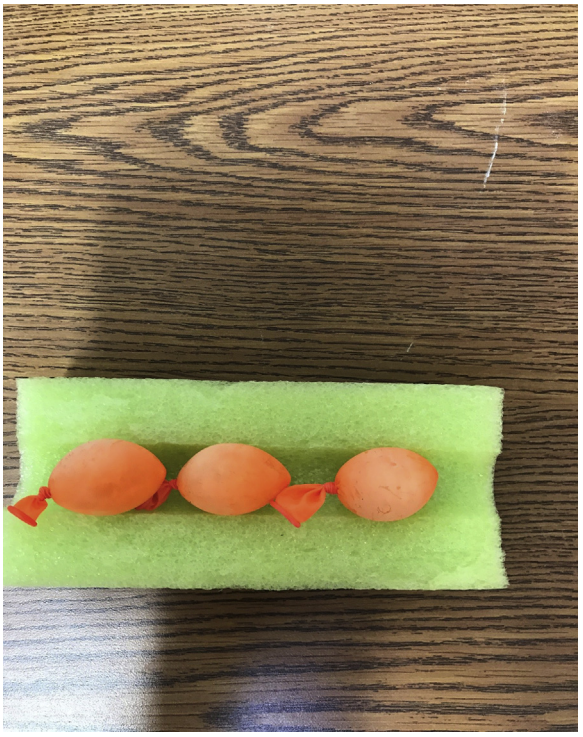

Figure 1 Three balloons filled with synthetic purulent material placed into the hollowed pool noodle before being secured with the synthetic tattoo skin and sealing tape.

participate in the SATS activity and complete a brief survey. Recruitment was done during hospital and university staff meetings, with all participants having greater than one year of clinical experience. The participants were asked to incise and drain the simulated abscess using a scalpel per hospital protocol for I&D procedures. Once completed, the subjects completed a survey (Appendix 1) addressing the realism of the procedure when compared to I&D on patients. Respondents were asked whether they would recommend the

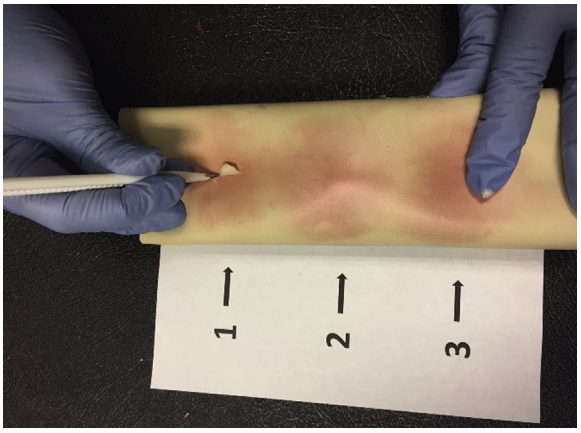

Figure 2 The constructed subcutaneous abscess task simulator with three balloon abscesses, secured under the synthetic tattoo skin, dusted with pink blush, and incised using a #11 blade.

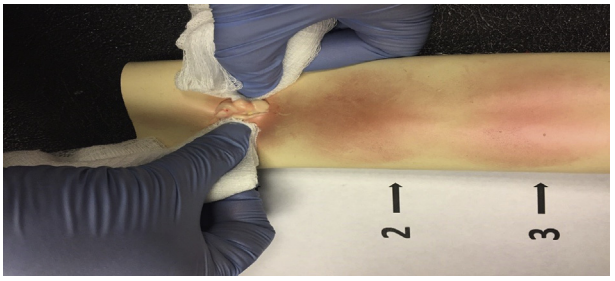

Figure 3 Expression of mock purulent material was accomplished by placing peripheral pressure at the incision site.

SATS for students and providers transitioning into primary care, urgent care, and emergency medicine. The survey was placed into a plain envelope without identifiers and collected by a coinvestigator. All participation was voluntary, and this project has been approved by the health system and a university Institutional Review Board.

Results

The SATS was assessed by 17 health care providers. Participants (17/17) were able to properly palpate fluctuance. Incision of the simulated subcutaneous abscess resulted in successful expression (17/17) of synthetic purulent material within the small balloons. Purulent material was easily expressed from pressure applied around the sides of the incision.

Peer assessment of the subcutaneous abscess simulator by 10 physician assistants and seven physicians found the task simulators to be realistic and a useful teaching tool. According to the evaluation survey (Appendix 1), 17/17 reviewers recommended using the SATS for physician assistant students and clinicians before performing the procedure on patients, for maintaining clinical skills and those transitioning into primary care, urgent care, and emergency medicine. Reviewers (16/17) recommended utilizing the SATS for continuing medical education, whereas one reviewer was

Table Estimated Cost of Materials

Materials	Price
Tattoo World™ tattoo practice skin	$0.90/sheet → 1 SATS
Instant pudding mixture	$0.28/ounce → 3 balloons
Swim noodles	$0.99/noodle → 10 SATS
Ben Nye™ synthetic blood	$0.28/gram → 100 balloons
Yellow food coloring	$1.22/ounce → 300 balloons
Mayonnaise	$0.22/ounce → 3 balloons
Small balloons	$0.01/balloon
Sealing tape	$0.99/55 yards
Pink cosmetic blush	$1.56/0.06 ounces
60 cc syringe	$0.73/syringe
Total	$1.57/for one SATS

Note. SATS = subcutaneous abscess task simulator.

not familiar with the use of simulation for continuing medical education but stated it was ''otherwise a great simulator.'' One limitation of this project was the lack of nurse practitioner and clinical nurse specialist participation as their perceptions may be different.

Conclusion

The objective of this project was to successfully develop a cost-effective, realistic subcutaneous abscess simulator to teach proper I&D technique to physician assistant students. Task simulators are important tools to utilize in the classroom setting because it gives health care providers and students the opportunity to perform invasive procedures without putting patients at risk. Finding a realistic and cost-effective subcutaneous abscess simulator was challenging. The SATS requires no special handling, refrigeration, storage, or special facilities. It is imperative to create innovative and cost-effective simulators for invasive procedures while training physician assistant, nurse practitioner, and medical students to provide realistic clinical skill practice in a safe and controlled environment. Further studies may validate this model as an effective teaching and learning tool.

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Supplementary Data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecns.2019.08.001.

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