The Journal of Emergency Medicine, Vol. 49, No. 3, pp. 313–317, 2015

0736-4679/$ - see front matter

ELSEVIER

http://dx.doi.org/10.1016/j.jemermed.2015.04.005

Techniques and Procedures

COST-EFFECTIVE, REUSABLE, LEAK-RESISTANT ULTRASOUND-GUIDED VASCULAR ACCESS TRAINER

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☐ **Abstract—Background: Ultrasound guidance for insertion of a peripheral venous catheter is becoming common practice in many emergency departments in the difficult-to-access patient, and simulation has become an important tool for health care practitioners to learn this technique. Commercial trainers are expensive, and low-cost alternatives described to date provide a suboptimal training experience. We introduce ballistics gel as a new material for the creation of simulating phantoms. Materials and Methods: Directions describe construction of a simulating phantom composed of 10% ballistic gelatin and commonly available latex tubing. The model's success as used by one residency training program and medical school is described. Results: Cost per phantom was $22.83, with less than an hour preparation time per phantom. We found these phantoms to offer a comparable user experience to commercially available products and better than other homemade products. Discussion: Ballistics gel is a novel material for production of simulation phantoms that provides a low-cost, realistic simulation experience. The clear gel material works well for novice learners, and opacifying agents can be added to increase difficulty for more advanced learners. The material offers flexibility in design to make models for a broad range of skill instruction. Conclusion: A relatively quick and easy process using ballistics gel allowed us to create a simulation experience similar to commercially available trainers at a fraction of the cost.** © 2015 Elsevier Inc.

☐ **Keywords—ultrasound; medical education; ultrasound simulation; peripheral vascular access**

INTRODUCTION

Ultrasound guidance for insertion of a peripheral venous catheter is becoming common practice in many emergency departments (EDs) in the difficult-to-access patient. Ultrasound-guided peripheral venous cannulation is now a mandatory skill for Emergency Medicine Residents (1). Simulation has become an important tool for health care practitioners to learn this technique, allowing the learner to perform the procedure in an ideal setting, to recreate mistakes in a safe environment, and to troubleshoot the procedure prior to attempts in living patients.

Procedural simulation for venous cannulation requires a model providing the learner with a realistic tactile, haptic, visual, and cognitive experience. Commercial trainers are available, but cost between $400 and $549 (Blue Phantom Corporation, Redmond, WA/Universal Medical, Inc. Norwood, MA). The relatively high cost has led multiple authors to describe low-cost tissue-simulating phantoms using Metamucil, gelatin, chicken breast, or bologna to achieve realistic tactile and sonographic characteristics (2–5). However, all require refrigeration, some can pose risk of transmission of pathogens such as *Salmonella* and *Campylobacter* without proper handling, and all have limited capacity for reuse. Gelatin models have become the most popular of these methods, but melt rapidly when used at room temperature, can leak with successful puncture,

RECEIVED: 1 November 2014; FINAL SUBMISSION RECEIVED: 30 March 2015;
ACCEPTED: 7 April 2015

and fall apart with multiple uses. We introduce ballistics gel as a new material for the creation of simulating phantoms. With ballistics gel, there is no risk of transmission of pathogens such as when using raw meats. In contrast to Metamucil or gelatin, ballistics gel retains all its simulation properties without leaking or falling apart, even during extended training sessions, in which it is exposed to warmer temperatures and is used continuously and repeatedly.

MATERIALS AND METHODS

Required Materials

- 10% ballistic gelatin (Clear Ballistics, LLC, Fort Smith, AR), a 100% synthetic material, nontoxic, odorless, clear material
  - Size: 9 inches long, 4 inches width, and 4 inches high
  - Weight: 4.5 lbs (2.04 kg) volume: 144 cubic inches (2359 mL)/2.5 US quarts
  - $36.66
- Heating equipment
  - 3-quart (2800 mL) sauce pan or pot with lid
  - 13 × 9 × $2^1/_4$ -inch cake/cookie pan
  - Heating element (stove range, Waring SB30 1300-Watt Portable Single Burner Range)
    - Alternative heating element via oven safe container set at 93.3°C (200°F)
  - Culinary temperature gauge
  - Personal protective equipment (gloves, apron, eye protection)
- 60-mL catheter tip syringe
- Hemostat
- Packing tape
- Latex tubing. Sizes range from internal diameter of 8 mm–1.5 mm. Multiple sizes available (Latex-tubing.com). Prices range from 0.75-0.89$ per foot of material and are cheaper if bought by the reel of 50 ft ($25 dollars/50 ft or 0.50$ per foot.)

Construction Process

Step 1: 13 × 9-inch pan and vessel lane setup

Taking approximately 12 inches (30.4 cm) of your latex rubber tubing, tie off one end completely with a knot (Figure 1).

Tape each vessel's knotted terminus with packing tape to the bottom of the pan at one end. Apply slight tension and tape the open end of the tubing to the opposite end of the pan with the opening projecting from the pan (Figure 2).

Figure 1. Twelve inches of rubber tubing tied at one end.

The finished product can contain 4–5 lanes of vessels, each of which can be divided for individual stations once the project is completed.

Additional latex tube segments can be placed in each lane to simulate adjacent veins or arteries.

Step 2: Gel melting, layer 1

Carefully read your manufacturer's product information prior to proceeding. Clear Ballistics, LLC recommends performing this melting process in a well-ventilated space, as exceeding recommended temperatures will cause boiling and release of vapors. Refer to the material safety data sheet (MSDS) of your product for specific safety recommendations.

Manufacturers' recommendations may vary; 10% ballistic gel has a melting point of around 93.3°C (200°F). Clear Ballistics recommends using a slow cooker and monitoring the temperature. In our process, using a Waring SB30 1300-watt portable single-burner range (Conair Corporation, Stamford, CT) on "low" setting, the gel melted completely within 20 min at a temperature of around 93.3°C (200°F) using a standard culinary temperature gauge. Break the gel into pieces (Figure 3) to speed the melting process.

Fill a 3-quart pot up to about 2/3 with broken gel pieces and cook on low, covered, until gel is completely melted and in liquid form. Pour the liquid gel into the baking pan with the latex vessel lanes. Be careful, as the material is very hot when it is being poured, and

Figure 2. 13 × 9-inch baking pan with the tied tubing taped to the base and the open end taped to the upper rim.