Comparison of a High-Fidelity Peripheral Venous Access Phantom to a Commercial Phantom

Presenting Authors: Shiv Patel, B.S., UC San Diego, Preetham Suresh, MD, UC San Diego Department of Anesthesiology
Co-Authors: Shiv Patel, B.S. UC San Diego, Preetham Suresh, MD, UC San Diego Department of Anesthesiology

Introduction: Ultrasound (US) guided peripheral venous access is an increasingly common procedure that reduces the use of central lines and their complications such as pneumothorax, arterial puncture, and Central Line-Associated Bloodstream Infection [1]. One barrier to wider adoption is provider comfort with this technique. Despite the commercial availability of procedural training phantoms, their widespread availability is limited due to their cost [2]. As a result, many institutions have described methods of developing low-cost phantoms for peripheral venous access training [2]. Unfortunately, many of these models lack fidelity and have suboptimal US image quality/echogenicity [3]. There is also a lack of objective comparisons of these do-it-yourself solutions and commercially available phantoms. This study seeks to provide an approach for comparison and uses said approach to assess our low-cost solution.

Methods: Ballistics gel (Clear Ballistics - Smith, Arkansas), dye, and flour were heated and mixed in a metal container for 2 hours and poured into a 3D printed nylon mold with steel rods placed to simulate blood vessels. Then the mold was placed in an oven for 30 minutes at 300℉ to allow time for bubbles to clear. After cooling, the metal rods were removed from the phantom leaving the simulated blood vessels behind which were melted shut at both ends and injected with water. Five experts who perform/teach ultrasound guided peripheral access were asked to target two veins in Block A (our model) and Block B (commercial model) and then fill out an assessment form. Five categories were used for comparison: US image realism, US needle visualization, vein compression, haptic feedback, vein depth. The small sample size in this case is validated by a mathematical model that shows 5 experts in a field will capture 80% of the data that is available about a model [4].

Figure 1. In each category, the data suggests that there is no difference between Block A and Block B when compared to a patient.

Results: The data suggests that experts find no difference between the Block A and Block B in all five categories since the average rating for US needle visualization, vein compression, haptic feedback we're not statistically different (3.6, 3.2, 3.0) and a two-tailed t-test yielded p-value=0.374 and 0.704(α=0.05) for US image realism and vein depth respectively. Furthermore, the data also suggests that 80% of the experts prefer Block A over Block B for training. In terms of cost, Block A is $7.90, with negligible cost to re-melt the phantom over many years, and the commercial model is $628.
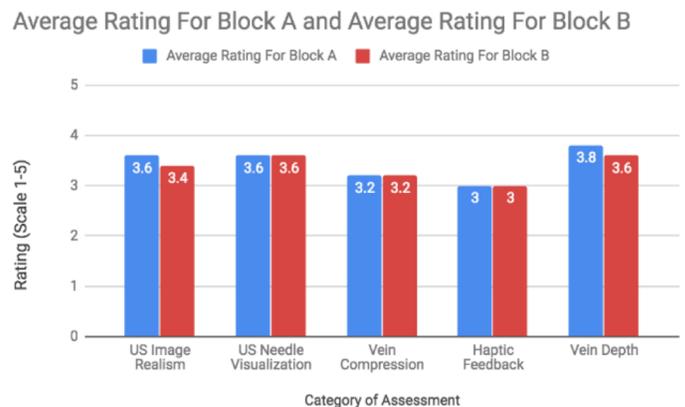
Discussion: This model offers a similar experience to commercially available vascular trainers for a fraction of the cost. Additionally, the trainer can be re-melted to refurbish the phantom back to new and eliminate any prior needle tracks. Furthermore, 3D printing allows for precision and customization in the model, but silicone molds and metal trays are also viable options for institutions that do not have access to 3D printers. To quantify the impact of increased phantom availability, we plan to outfit all ultrasounds across our facility with a vascular access phantom to allow for Just-in-Time(JIT) practice (practicing a procedure before performing it on a patient) which has been shown to increase procedural confidence, skills, and decreases supervisor intervention [5].

References
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