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Novel Peritonsillar Abscess Task Simulator

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Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

Abstract

The management of peritonsillar abscesses is a skill developed early in residency training. Although drainage is not technically complicated, the procedure is intimidating to the neophyte. Task simulators have become increasingly common to provide training opportunities in a controlled environment. The authors designed a peritonsillar abscess simulator using a latex moulage of the oral cavity and other common materials. Twelve medical professionals of various levels of experience were instructed to expose, anesthetize, aspirate, and drain the simulated abscess. After completion, a questionnaire was completed by each volunteer: Initial impressions were positive that the model adequately replicated the tasks requisite for abscess drainage and was suitable as an instructional device. The initial construct cost was approximately 10 dollars, with disposables costing roughly 25 cents. Further research is under way to formally assess the simulator for face, content, and construct validity.

Keywords

peritonsillar abscess, task simulation, simulator, graduate medical education

Introduction

Simulators are becoming an increasingly common tool in surgical residency training to teach physicians proper skills and techniques as an adjunct to live patient encounters.1 Simulated medical environments allow for safe repetition of tasks in a controlled environment that encourages the freedom to explore and err, with the added ability to “suspend” time to reflect upon performance. Various otolaryngology-related simulators have been produced to aid residents as well as faculty in a variety of skill tasks. They range from simple, low-cost models to highly complex computer-simulated environments akin to flight simulators.2-5

Peritonsillar abscess (PTA) is one of the most common deep head and neck infections, formed from an untreated, or undertreated, tonsillar infection.6 Although drainage of a PTA is not technically complicated, the procedure can be intimidating to the newly minted resident on call. Oftentimes, transoral drainage of a PTA can be safely performed in an emergency room setting, obviating the need for an operating room. Challenges of the procedure include obtaining adequate visualization and illumination of the posterior oropharynx, managing the social and physical discomfort of the patient, finding and draining the abscess, and coping with provider anxiety provoked by the relative anatomic proximity of the carotid artery. Training to drain a PTA typically occurs “on the job” with a live patient under the guidance of a senior physician. Although inevitably every learner must go through a “first time” experience, a PTA simulator may provide better preparation prior to the first patient encounter.

Increased attention to patient safety in the teaching environment as well as resident work hour restrictions have spurred interest in simulation technologies. However, monetary support of resident education continues to be in short supply. Simulators therefore must balance fidelity and realism with cost. Expensive simulators that are applicable to the training of only a small population of residents—as is the case in otolaryngology—for a limited skill may not be financially justifiable.

To our knowledge, there are no published task simulators for draining PTAs. It was our desire to make a simulator of good fidelity (both visually and kinesthetically) that was low in cost and easy to reproduce. In this commentary, we share the construction of our PTA simulator, demonstrate its use, and report preliminary impressions from 12 medical professionals. This study received exemption from the University of Missouri Institutional Review Board.

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Simulator Assembly

Construction of the PTA task simulator was performed by a team of otolaryngologists (S.R.T., C.W.D.C.) and simulation center staff member (Faith A. Phillips, BSN, RN). The oral cavity was recreated using a latex moulage technique similarly used to create Hollywood-style latex masks. A clay mold was sculpted to create the “negative space” of the oral cavity. It is hemispherical in shape, with indentations representing the uvula, a normal left tonsil, and a larger infected right-sided tonsil (Figure 1). A positive cast of the mold was used to create the latex moulage by applying 3 layers of flesh colored liquid latex (Alcone Company, Long Island City, New York, USA) over the mold. Each layer was allowed to dry several hours before the application of the subsequent layer. The final layer was allowed to dry overnight. The resulting latex moulage was separated from the mold (Figure 2A). A rubber band was used to secure the moulage over the end of a 3-inch-long segment of a 2.5-inch-diameter polyvinylchloride (PVC) pipe, which was used to recreate the space of the oral cavity. An abscess construct was created by wrapping a small balloon filled with abscess liquid and placing it within 3-mm-thick polyurethane foam. The abscess liquid was created by mixing 1.75 teaspoons sugar-free vanilla pudding powder with 30 cc of coffee creamer. The foam created a submucosal space to separate the latex mucosa from the balloon abscess. The foam was perforated with multiple 1-inch slits to facilitate penetration of instruments through this layer to reach the balloon. The foam/balloon abscess construct was secured with packing tape behind the latex hollow of the right tonsil (Figure 2B). Lips were constructed using a clay model and latex. The oral opening was 5 cm wide and 3 cm high. The lips were secured to the opposite end of the 2.5-inch PVC pipe using a metal worm drive clamp. A rubber tongue taken from a patient simulator mannequin (METIman; CAE Healthcare, Sarasota, Florida, USA) was secured to the inside of the PVC pipe with Velcro, completing the PTA simulator.

The PTA construct was held for use by a 3-inch rubber cap mounted to a vertically oriented piece of plywood (Figure 3). The inner circumference of the rubber cap was lined with foam tape, which allowed for easy removal of the PTA construct, facilitating replacement of the latex moulage and abscess balloon after each use. A flexible gastrointestinal endoscope was passed through a hole cut into the side of the PVC pipe. An endoscopic tower was attached to the scope to enable video recording of the surgical task.

Construct Evaluation

Participants in the pilot study included faculty members, residents, and rotating medical students from the University of Missouri Department of Otolaryngology. Each volunteer was given the same instruments (headlight, local anesthetic, 5-cc syringe, 10-cc control top syringe, 27-guage 1.5-inch needle, 18-guage 3.5-inch spinal needle, No. 11 blade scalpel, and curved Kelly forceps) and an instruction sheet regarding the steps to follow to drain the abscess. The performance of each participant was recorded using 2 cameras: (1) a room camera with a wide angle view used to globally capture each participant’s preparation and approach and (2) an endoscopic camera used to capture performance of the task as viewed from inside the simulator.

Following the procedure, a questionnaire was administered to each participant. Using a 5-point Likert-type scale,
Participants were asked 13 questions, rating the simulator’s ability to replicate and teach tasks required to drain a PTA, the fidelity of the model, and the value of the task simulator for teaching. Each participant’s level of training and prior experience with PTA management were also recorded. Twelve medical professionals initially evaluated the PTA simulator. The participants included 2 medical students, 8 residents of varying years of training, and 2 attending physicians. Participants show a bimodal distribution of number of abscesses drained. Five participants had drained >15 and 5 participants had drained 0 to 2. All participants felt that the tasks performed on the simulator replicate the skills necessary to drain a PTA. More than 90% agreed or strongly agreed that the simulator helped with learning to anesthetize the oropharynx and aspirate and incise the abscess. Regarding anatomic fidelity, opinion was split, with 50% expressing that the moulage did not represent the posterior oropharynx accurately. It is surprising that the less experienced physicians tended to provide lower scores regarding anatomic fidelity than the more experienced physicians. This may be because young residents’ cognitive understanding of PTA management is reliant more on the visual experience than on kinesthetic (feel) and abstract cognitive appreciation.

Discussion

Simulators and task trainers are increasingly an important aspect of medical training. Simulators allow residents to be exposed to new situations and procedures in a safe manner. Techniques can be practiced repetitively to develop the skills necessary to operate more smoothly and more confidently. Although PTA drainage is a very common procedure, young residents may not manage their first PTA until on call. Proper drainage of an abscess requires good technique, illuminated visualization, adequate anesthesia, and thorough evacuation of the abscess pocket. Furthermore, having confidence in one’s ability to drain a PTA is imperative, given that the patient is typically awake, in pain, and anxious. The techniques mastered in this task may also be applied to other transoral procedures, where use of a headlight, adequate exposure, and bimanual dexterity is required.

In developing a simulator, the authors prioritized minimizing cost while maximizing manufacturing simplicity to promote accessibility of the device to other training programs. We refrained from adding other features to the model, such as carotid arteries, to reduce construction complexity. In the spirit of freely sharing this simulator, we wanted to eliminate any specialized manufacturing and use
easily obtainable materials. Mass production of such a trainer may not be a suitable business endeavor given the limited number of target consumers (PGY1 and 2 otorlaryngology residents) and the limited time of user engagement (given the relatively mild learning curve of this task). Thus, reproduction of the simulator needs to be relatively simple to permit easy replication. Initial supply cost is approximately 10 dollars. The disposable portions of the simulator that require replenishment between uses (abscess balloon, foam, and latex moulage) cost less than 25 cents. All supplies can be easily obtained at hardware stores and hobby stores, with the exception of the tongue, which was borrowed from a simulator mannequin. A suitable tongue substitute could probably be made from polyurethane foam. Most of the time required for actual assembly of the simulator was spent allowing the latex moulage to dry, which we did overnight. The remainder could be assembled in 5 to 10 minutes.

The above cost analysis does not include time costs involved in making and assembling the simulator. The University of Missouri School of Medicine, like many academic medical centers, houses a center dedicated to medical simulation. The lab is equipped with ceiling mounted cameras, a collection of endoscopes, and surgical video towers for use. The University of Missouri Hospital System and the School of Medicine recognize the value of simulator training and subsidize the use of the center for all academic departments. Financial arrangements and facility availability may differ at other institutions.

Philosophically, simulator development is a balance between realism and economic cost. Higher fidelity simulators usually come at a higher degree of complexity and/or cost. However, high-cost simulators may become macroeconomically practical if their absence generates a higher societal cost. From a microeconomic perspective, institutional funding of simulators can be challenging. Lower cost (and presumably lower fidelity) simulators have a role if they can still adequately provide psychomotor instruction and assessment of skills even though they sacrifice some realism. Thus, simulators must undergo validation through a variety of methodologies to demonstrate face validity (model realism), content validity (usefulness as a training tool), and construct validity (distinguishing performance between users of differing abilities).7

Other limitations of this study include the small number of participants in the evaluation of the simulator. Continued research is necessary to establish face, content, and construct validity of this device. We hope to gather more data from faculty physicians as well as other user experience data to demonstrate the viability of this simulator in resident training.

**Conclusion**

The role for simulators in resident training continues to expand as the demand for low-cost, but valid, models is increasing. The creation of a low-cost PTA simulator can provide task training without the risk of patient harm. Evaluations thus far favorably show this model to be a suitable instructional tool.

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**Author Contributions**

Steven R. Taylor, design, acquisition of data, analysis and interpretation of data, drafting the article, final approval of the version to be published; C. W. David Chang, conception and design, analysis and interpretation of data, revising article critically for important intellectual content, final approval of the version to be published.

**Disclosures**

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