Novel High-Fidelity Peritonsillar Abscess Simulator

Grace M. Scott, MSc1, Kevin Fung, MD, FRCS(C)1, and Kathryn E. Roth, MD, FRCS(C)1

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Abstract
Objective. To create and assess a novel high-fidelity peritonsillar abscess simulation task trainer with junior otolaryngology–head and neck surgery residents.

Study Design. Prospective cohort study.

Setting. Third annual Emergencies in Otolaryngology Head & Neck Surgery Bootcamp course at the Canadian Surgical Technologies & Advanced Robotics in London, Canada.

Subjects and Methods. Fresh cadaveric material was obtained consisting of a head and neck. Abscess pockets were simulated with a finger of a latex glove containing vanilla pudding to represent pus, tied off with a silk suture. These abscess pockets were inserted into the peritonsillar space from the transected neck inferiorly, passing medial to the great vessels into the parapharyngeal space. Faculty members evaluated the models to test content validity. The primary outcome measure was a postbootcamp survey evaluation assessing specific domains: learning objectives, effectiveness of faculty, and the quality and realism of models.

Results. When working with this model, learners were able to locate, visualize, and manipulate the abscess. The materials and positioning of the pockets created high-fidelity models that were realistic in appearance and haptics feedback.

Conclusions. A novel high-fidelity task trainer has been successfully developed to teach the technique of peritonsillar abscess incision and drainage. This task trainer is currently the highest-fidelity model reported in the literature. This model allows learners to practice a high-stakes emergency skill in a controlled environment, affording the opportunity to practice localization, visualization, and drainage of the abscess with a high level of realism.

Keywords
peritonsillar abscess, task trainer, medical education

Peritonsillar abscess (PTA) is one of the most common deep-space head and neck infections, formed from an untreated or undertreated tonsillar infection.1 Despite being a relatively trivial procedure from a technical standpoint, draining a PTA under local anesthesia in the emergency room can be an overwhelming procedure for junior otolaryngology–head and neck surgery (OtoHNS) residents. The main challenges of this procedure are localization of the abscess, appropriate use of equipment, management of patient discomfort, and proximity of the internal carotid artery. These challenges can be mitigated through the use of simulation. Simulation not only supports early acquisition of complex skills and is known to improve procedural skills but also improves surgeon confidence, patient care practices, and outcomes.2-6

There is no doubt that simulation-based medical education is superior to traditional clinical education for acquisition of a wide range of medical skills, patient safety, and quality.7 In otolaryngology specifically, skills have been demonstrated to be transferrable from simulation to procedures on actual patients (in vivo).2,8,9 Published in 1973, one of the earliest simulators in the field of otolaryngology was used to teach intubation.9,10 Since this time, simulators have been developed for advanced technical skills at other otolaryngology subsites, such as otology (temporal bone simulators) and rhinology. Even with such innovations, high-fidelity simulation that closely mimics live human tissue remains a challenge.10

Previous research revealed that a low-cost PTA simulator can provide task training without the risk of patient harm.11 This previous low-cost PTA model used a latex moulage of the oral cavity with aims for visual and kinesthetic accuracy.11 There may be instances, however, when a needs analysis dictates higher levels of fidelity for more advanced trainees.12 Instructors must determine whether the level of skill that can be acquired on lower-fidelity systems is sufficient for the number of learners that need to be trained in a given period.12 In the case of the present study, it was

1Department of Otolaryngology–Head and Neck Surgery, Schulich School of Medicine and Dentistry, Western University, London, Canada

Corresponding Author:
Kevin Fung, MD, Department of Otolaryngology–Head and Neck Surgery, Schulich School of Medicine and Dentistry, Western University, 800 Commissioners Rd E, London, ON N6A 5W9, Canada.
Email: kevin.fung@lhsc.on.ca
determined that a high-fidelity cadaveric model would be an appropriate choice for such high-stakes skill acquisition. Research evidence is clear that high-fidelity medical simulations facilitate learning among trainees when used under the right conditions.\textsuperscript{13} Essential components of functional fidelity can be identified by engaging a panel of experts in an analysis of the task of interest,\textsuperscript{14} as employed by the present study. This should be followed by the selection of the best simulator platform or context to address the educational goals.\textsuperscript{15}

The aims of this study were twofold: (1) to develop a novel high-fidelity PTA simulation task trainer and confirm content validity by faculty members and (2) to assess the realism of the task trainer with junior OtoHNS residents. We hypothesized that (1) a task trainer for PTA could be developed to a high degree of reality (high fidelity) as determined by a panel of experts and (2) the opportunity to practice in a hands-on workshop setting with the high-fidelity PTA task trainer would lead to basic procedural skill acquisition in novice postgraduate trainees.

\section*{Methods}

A prospective cohort study was conducted whereby PTA models were assessed by junior OtoHNS residents. Learners were taught in a small-group setting with the aid of a 15-minute PowerPoint presentation (Microsoft Corporation, Redmond, Washington) and introduction to the PTA models. This was followed by 45 minutes of practice time on the task trainer and one-on-one instruction from a board-certified otolaryngologist. Ethics approval was obtained via the Western University Research Ethics Board.

\section*{Participants}

All junior OtoHNS residents (postgraduate years 1 and 2) from various training programs in North America in attendance at the third annual Emergencies in Otolaryngology Head & Neck Surgery Bootcamp course held at the Canadian Surgical Technologies & Advanced Robotics in London, Canada, were invited to participate. Participation was voluntary, and none declined to partake. Exclusion criteria included previous experience working with the task trainer.

\section*{Material Preparation}

Fresh cadaveric material was obtained consisting of a head and neck. Abscess pockets were simulated with a finger of a latex glove containing vanilla pudding to represent purulence tied off with a silk suture. These abscess pockets were inserted into the peritonsillar space from the transected neck inferiorly, passing medial to the great vessels into the parapharyngeal space. Once within the peritonsillar space, these pockets were suspended upward by the silk suture through an incision made just above the zygoma. The sutures were passed through the infratemporal fossa and secured by external attachment of the suture to the head. The external attachment allowed instructors to manipulate or elevate the pockets to ensure proper positioning. Figure 1 shows an inferior view whereby the pocket is inserted into parapharyngeal space and pulled upward by silk suture with the Kelly clamp.

Two board-certified otolaryngologists with $>100$ peritonsillar procedures completed in live patients developed this model.

\subsection*{Outcome Measure}

Once pockets were in place, faculty assisted junior residents in PTA management and drainage. Outcome measures included program evaluation forms, administered upon completion of the bootcamp. Stations were assessed on meeting objectives, effectiveness of faculty, and the quality and realism of models.

Content validity was assessed via program evaluations from participating faculty.

\section*{Results}

Twenty-six junior OtoHNS residents from 14 residency training programs across Canada and regional United States participated in the third annual Emergencies in Otolaryngology Head & Neck Surgery Bootcamp at Canadian Surgical Technologies & Advanced Robotics. At such time, the PTA task trainer was assessed. Thirteen PTA task trainers were crafted with the described preparation technique. Figure 2 depicts an intraoral view showing the outline of pocket in the peritonsillar space. Figure 3 outlines a side view of the cheek after the pocket has been elevated into the peritonsillar space. All 26 learners (100\%) completed program evaluation forms upon completion.

Program evaluations revealed that 95\% of participants were in strong agreement that faculty members were effective and objectives were met. In addition, 81\% of participants were in strong agreement that the models were realistic and of good quality.
Content validity evidence was initiated by evaluation by 20 OtoHNS experts from a variety of academic centers, with both pediatric and adult OtoHNS experience. Nineteen (95%) faculty experts in OtoHNS across the country agreed that the models were of high fidelity in representing the appearance and experience of draining a PTA.

**Discussion**

The role of simulators in postgraduate surgical training is becoming increasingly evident. Like other high-risk, high-stakes activities, such as aviation, aeronautics, and military training, simulation allows for both surgical training and maintenance of skill.16

When working with this model, learners were able to locate, visualize, and manipulate the abscess. Learners were also able to incise and drain the abscess as they would in a live patient. The materials and positioning of the pockets created high-fidelity models that were realistic in appearance and touch.

In developing this task trainer, the main technical dilemma has been placing the pocket into the peritonsillar space without cutting the palate mucosa, as we want learners to practice draining the pocket without having an incision revealing the hidden abscess area. This indicates the need to access the peritonsillar space with a submucosal approach. The solution to this problem is placing the pockets in a tunnel from the neck into the parapharyngeal space and suspended upward into the cadaveric peritonsillar space.

Content validity for the models was confirmed by a majority of expert faculty attendees agreeing to the high-fidelity appearance and experience of the models. Previous research acknowledges that independent content experts can evaluate the reasonableness of the test blueprint—or, in this case, task trainer—with respect to the course objectives and the cognitive levels tested.17

The program requirements of the Accreditation Council for Graduate Medical Education for several specialties, including otolaryngology, accept or may even require the use of medical simulation as a mechanism for education and assessment of trainees, and several professional certification boards affiliated with the American Board of Medical Specialties accept or require simulation as a component of board certification or recertification.2 Diverse simulation experiences can be used to address each of the 6 core competencies of the Accreditation Council for Graduate Medical Education (patient care, medical knowledge, interpersonal and communication skills, professionalism, practice-based learning and improvement, systems-based practice).2,18,19

As part of current training, most otolaryngology residency programs have incorporated simulation into their curriculum.2 Currently, all Royal College of Physicians and Surgeons of Canada programs require demonstration of traditional time-based rotations and specialty-specific competencies.20,21

Continued research is necessary to assess the skill acquisition of learners when such a simulator is used. We hope to continue to evaluate the efficacy of this task trainer with...
future groups of OtoHNS learners. In addition, the degree to which a technical skill acquired by working with a model is translated to clinical skill should be evaluated. Specific investigations of skill retention measured by in-field experience and repeat task trainer testing are warranted.

Despite the aforementioned benefits of the proposed PTA task trainer, some challenges must be acknowledged. There may be certain practical barriers in the acquisition of cadaveric material at certain institutions. The bootcamp setting offered an educational platform for high-fidelity, specialty-specific task trainers such as this. This PTA cadaveric model allowed for multiple uses (as an additional tonsillar bleed trainer) and multiple purposes (later used for temporal bone course, sinus course, and research) and was made possible by research grants and industry sponsors. Regionalization of this educational program allowed for multiple learners to benefit from the model—in our bootcamp, centralization of resources involved faculty and learners from across the continent. In this instance, the level of fidelity of the model outweighs the costs and challenges associated.

Conclusions
A novel high-fidelity task trainer has been successfully developed to teach the technique of PTA incision and drainage. This task trainer is currently the highest-fidelity model reported in the literature. This model allows learners to practice a high-stakes emergency skill in a controlled environment, affording the opportunity to practice localization, visualization, and drainage of the abscess with a high level of realism.

This PTA simulator may play an increasingly important role in residency education in the current era of competency-based education and heightened awareness of patient safety.

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Grace M. Scott: research ethics, data collection/analysis, manuscript preparation; Kevin Fung: study design, data analysis, manuscript preparation; Kathryn E. Roth: study design, data analysis, manuscript preparation.

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