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Ear Disease Knowledge and Otoscopy Skills Transfer to Real Patients: A Randomized Controlled Trial

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OBJECTIVE: To determine which teaching method—otoscopy simulation (OS), web-based module (WM), or standard classroom instruction (SI)—produced greater translation of knowledge and otoscopy examination skills to real patients.

DESIGN: In a prospective randomized controlled nonclinical trial, medical students were randomized to 1 of 3 interventional arms: (1) OS, (2) WM, or (3) SI. Students were assessed at baseline for diagnostic accuracy and otoscopy skills on 5 volunteer patients (total of 10 ears), followed by the intervention. Testing was repeated immediately after intervention on the same patients. Student reported confidence in diagnostic accuracy and otoscopy examination were also captured. Assessors were blinded to the intervention group, and whether students were pre- or post-intervention.

SETTING: Clinical Teaching Centre, Queen's University.

PARTICIPANTS: Twenty-nine participants were initially randomized. Two students were unable to attend their specific intervention sessions and withdrew. Final group sizes were: OS—10, WM—9, SI—8. Five patients with external/middle ear pathologies were voluntarily recruited to participate as testing subjects.

RESULTS: Baseline diagnostic accuracy and otoscopy clinical skills did not differ across the groups. Post-intervention, there were improvements in diagnostic accuracy from all groups: OS (127.78%, 2.30 ± 1.42, $p = 0.0006$), WM (76.40%, 1.44 ± 1.88, $p = 0.0499$), and SI (100.00%, 1.50 ± 1.20, $p = 0.0093$). For otoscopy skills, post-intervention improvements were noted from OS (77.00%, 3.85 ± 2.55, $p < 0.0001$) and SI (22.20%, 1.25 ± 1.20, $p = 0.0011$), with no significant improvement from WM (13.46%, 0.78 ± 1.92, $p = 0.1050$). Students across all groups reported significantly improved confidence in diagnostic accuracy ($p < 0.0001$) and otoscopy skill ($p < 0.0001$) after the intervention.

CONCLUSION: All 3 teaching modalities showed an improvement in diagnostic accuracy immediately post-intervention. Otoscopy clinical skills were found to have increased only in OS and SI, with the OS group demonstrating the largest improvement. Simulation-based medical education in Otolaryngology may provide the greatest transfer of medical knowledge and technical skills when evaluated with real patients. (J Surg Ed ■:■■■-■■■. © 2018 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: medical education, otoscopy, simulation, web-based learning module

COMPETENCY: Medical knowledge

BACKGROUND

The development of simulation-based training models has drastically changed the educational environment of modern medical schools, allowing for more hands-on and active learning.[1–3] Specifically within Otolaryngology, simulation has filled important learning gaps in both the undergraduate and postgraduate medical curricula.[4,5] For ear disease, there currently exists a number of commercially available simulators, including the web-based OtoTrain, the Life/form Diagnostic and Procedural Ear Trainer, the Earsi Otoscope, and the OtoSim Ear Training and Simulation System.[6–12] Various validation studies have been performed on these simulators, with some having shown significant improvements in both the diagnosing capabilities as well as technical skills of

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medical trainees.[6,12,13] Additionally, simulators have also been shown to be effective in increasing the diagnostic confidence of students and their interest in Otolaryngology.[14]

Our research group previously established that the acquisition and long-term retention of knowledge and clinical skills were highest from students who participated in simulation-based teaching, compared to web-modules and classroom lectures.[12] Unlike other modalities of learning that are commonly employed by medical schools today, simulation-based learning can provide students the opportunity to mimic what they will encounter in a clinical setting. At the same time, simulators reduce the need for multiple volunteer patients, which is often required for the repetitive exposure that is needed for clinical skills to develop.[5]

The ultimate goal of simulation-based medical education is to translate the knowledge and skills learned in a simulated environment to that of a clinical setting, to improve patient care and outcomes.[15,16] Such successful translations have been documented in the past. However, it is important to note that research in simulation-based education showing transfer of learning to clinical practice is difficult to design and conduct.[6,17] Many of the studies currently published on simulation-based medical education in the field of Otology have measured student performance on the simulator that was used as part of the training.[12,13] Clearly, the limitation of this approach is that it may bias the results, favoring those trained on the simulator. These participants may have increased familiarity from additional exposure. Testing on a surrogate measure has also been explored previously.[6,18] However, without direct comparison to students' performance in an actual clinical context, it is still difficult to postulate whether surrogate measures are true and accurate reflections of students' learning.

To date, simulation-based education within Otolaryngology has not identified knowledge and skill translation to real patients, which is the gold standard in assessing the utility and effectiveness of an educational intervention.[15,16] Herein, we aimed to evaluate this by directly comparing 3 different teaching modalities: otoscopy simulation (OS), web-based module (WM), and standard classroom instruction (SI).

METHODS

This prospective randomized controlled nonclinical trial (RCT) was approved by the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board (#6019936) and the Queen's University School of Medicine Undergraduate Medical Education Curriculum Committee.

Participants

All first and second year medical students from Queen's University were recruited to voluntarily participate in the study. Students were excluded if they had previous training on the studied otoscopy simulator or if they had participated in previous research studies using the studied otoscopy simulator. Written consent was obtained from each student prior to beginning the study. The sample size was determined based on the previous educational study conducted by our research group, evaluating diagnostic accuracy and otoscopy skill across 3 interventional arms.[12] Based on the smallest significant effect size of 2.54 observed between groups and a standard deviation (SD) of 1.29, our sample size was calculated to be 5 participants per intervention arm based on $\alpha = 0.05$ and $\beta = 0.20$. To ensure the study was adequately powered, we aimed to recruit at least 6 participants per intervention arm.

Patients from an Otology/Neurotology Outpatient Clinic with current otologic pathologies were invited to participate in the study as volunteers to be examined. Written consent was obtained from each patient prior to being enrolled in the study. Of the 5 patients who volunteered to participate, 2 had bilateral pathologies and 3 had unilateral pathologies (total of 7 pathological and 3 normal ears).

Design

Following recruitment, students were randomized to 1 of 3 parallel educational intervention arms (OS, WM, or SI) following simple randomization using a random numbers generator (http://www.random.org). The study flow diagram is shown in Figure 1.

Students underwent baseline testing prior to receiving their intervention. The testing session was designed as an objective structured clinical examination (OSCE), whereby students were given 2.5 minutes to examine both ears of a volunteer patient, rotating through all 5 patients. Students were instructed to focus only on the otoscopy examination. Responses were written on provided answer sheets and submitted into opaque slotted envelopes inside each patient room following the examination. Answers from other students were not accessible and no discussion was permitted between students during testing. Students were video-recorded during one of the patient encounters, in order to capture their otoscopy clinical skills.

Following baseline testing, students underwent their assigned educational intervention. All interventions were 30 minutes in duration and included the same teaching material: otoscopy examination techniques and 25 images of middle and external ear pathologies including images of normal ears.[12] Examples of pathologies utilized included acute otitis media, serous otitis media, tympanic membrane perforation, exostosis, and cholesteatoma. Students were asked not to take notes during the intervention sessions. Immediately following the intervention, testing was repeated, which was again video-captured. The baseline testing, intervention, and post-intervention testing all took place over the course of the same day, whereby all students were assessed on the same 5 volunteer patients.