ORIGINAL REPORT

Current Status of Simulation in Otolaryngology: A Systematic Review ☆

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OBJECTIVE: Otolaryngology is a highly technical and demanding specialty and the requirements for surgical trainees to acquire proficiency remains challenging. Simulation has been purported to be an effective tool in assisting with this. The aim of this systematic review is to identify the available otolaryngology simulators, their status of validation, and evaluation the level of evidence behind each training model and thereby establish a level of recommendation.

DESIGN: PubMed, ERIC, and Google Scholar databases were searched for articles that described otolaryngology simulators or training models between 1980 and April 2016. Any validation studies for simulators were also retrieved. Titles and abstracts were screened for relevance using the preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidelines. Level of evidence (LoE) and Level of recommendation (LoR) was awarded to each study and model, respectively.

RESULTS: A total of 70 studies were identified describing 64 simulators. Out of these, at least 54 simulators had 1 validation study. Simulators for the ear and temporal bone surgery were the most common ($n = 32$), followed by laryngeal and throat ($n = 20$) and endoscopic sinus surgery ($n = 12$). Face validity was evaluated by 29 studies, 20 attempted to show construct, 20 assessed content, 20 transfer, and only 2 assessed concurrent validity. Of the validation assessments, 2 were classified as Level 1b, 10 Level 2a, and 48 Level 2b. No simulators received the highest LoR, but 8 simulators received a LoR of 2.

CONCLUSIONS: Despite the lack of evidence in outcome studies and limited number of high-validity otolaryngology simulators, the role of simulation continues to grow across surgical specialties Hence, it is imperative that the simulators are of high validity and construct for trainees to practice and rehearse surgical skills to develop confidence. (J Surg Ed ▮:▮▮▮-▮▮▮. © 2016 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: otolaryngology, ENT, simulation, training, validation, systematic review

COMPETENCIES: Patient Care, Practice-Based Learning and Improvement, Interpersonal and Communication Skills

INTRODUCTION

With restrictions on working hours such as the European Working Time Directive, associated with a culture of greater outcome expectations, there is a drive toward improving efficiency in surgical skills acquisition. This has led to the adoption of simulation-based training in many surgical specialties including otolaryngology.[1]

Otolaryngology is a highly technical and demanding specialty where the requirements for surgical trainees to acquire proficiency remains a challenge.[2] Simulation-based surgical education has been demonstrated to be an effective tool in surgical skill acquisition.[3] With benefits of having well-documented simulation training, there are an increasing number of surgical simulators being developed.

Simulators can be categorized into synthetic bench models, animal models (tissue or live), human cadavers, and virtual reality (VR) simulators.

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TABLE 1. Definitions of Validity (Adapted From McDougall[5] and Van Northwick et al.[6])

Type	Definition
Face validity	Degree to which the simulator resembles clinical scenarios, i.e., realism
Content validity	Whether the domain or criteria attempting to be measured is actually being measured by the assessment tool or simulator
Construct validity	Capability of the simulator to distinguish between different levels of expertise
Transfer validity	A gage of whether the simulator has the effect it proposes to have, i.e., will the simulator improve performance while operating through a consequence of learning
Concurrent validity	Comparison against the "gold" standard

The aim of this study is to identify the available otolaryngology simulators described in the literature, their status of validation and level of evidence (LoE), and hence, establish a level of recommendation (LoR).

METHODS

Search Methods

PubMed, ERIC, and Google Scholar databases were searched for articles that described Otolaryngology simulators or training models between 1980 and April 2016. Any validation studies of the simulators were also retrieved. The search terms included a combination of "otolaryngology," "ear," "throat," "nose/nasal," "pharynx/geal," "temporal bone," "skull base," "tonsil," "larynx/geal," "phonosurgery," "thyroid," and "simulator" or "simulation." Titles and abstracts were screened for relevance using the preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidelines.[4]

Selection Criteria

Articles describing otolaryngology training simulators or those that validated an existing model were included. Models and simulators were classified into the following categories: VR, bench, cadaver, and animal models. Where relevant, these categories have been further expanded to include the use of any additional apparatus of the type of model.

Data Extraction

Following database screening using the aforementioned criteria, the remaining articles were examined. Duplicates and articles describing software and early designs were removed. If there was a description of any otolaryngology simulator, they were included.

Data Analysis

Outcomes for the validation studies were reported according to the definitions of McDougall[5] and van Nortwick et al.[6] (Table 1). Two authors (O.M. and A.A.) independently assessed the studies that did not state the type of validation and were classified according to the standardized definitions.[5,6] If there was any disagreement on the assesmsent, then a third author was invovled in the process of validation assignment. The same 2 authors assigned a LoE for each study and LoR for each model was awarded using a modified educational Oxford Center for Evidence-Based Medicine classification system, as adapted by the European Association of Endoscopic Surgery,[7] where a LoR of 1 is the highest and 4 is the lowest.

RESULTS

The search criteria yielded 1666 articles, of which, 70 studies met the inclusion criteria (Figure).

Description of Otolaryngology Models

Of the 70 articles included, 64 simulators were described (Table 2) and 54 simulators had at least 1 validation study. Simulators for surgical procedures of the ear and temporal bone were the most common ($n = 32$), followed by laryngeal and throat ($n = 20$) and endoscopic sinus surgery ($n = 12$).

Laryngeal and Throat Surgery

A total of 14 studies were identified,[8-21] each describing a different simulator for laryngeal surgery, whereas only 2 were tonsil simulators.[20,21] The identified models consisted of bench models ($n = 7$), VR simulators ($n = 1$), animal ($n = 5$), and cadaver ($n = 1$) models, all of which were developed at a university or a university-affiliated hospital. Of the simulators, 4 were assessing vocal fold injection and 3 used lesion excision. The Dundee Endoscopic Pyschomotor Otolaryngology Surgery Trainer simulator was assessed using an endoscope to identify a series of lights in a complex 3-D model.[19] There were also 6 thyroid procedural simulators,[22-26] with 2 of the studies using TraumaMan.[23,25]

Myringotomy With Ventilation Tube Insertion and Middle Ear Surgery

Myringotomy with ventilation tube insertion were the most commonly described simulators, with 12 studies describing a simulator.[27-38] Among them, 9 were bench-top models and 3 were VR with the most common being the VR