A Randomized Controlled Trial of Nasolaryngoscopy Training Techniques

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Objectives/Hypothesis: Flexible nasolaryngoscopy is an essential skill for otolaryngology trainees to develop, but there is a lack of standardized training for this procedure. The aim of this study was to assess whether using training on a realistic human mannequin together with structured video feedback improved trainees’ performance at flexible nasolaryngoscopy.

Study Design: Three-armed, single-blinded, randomized controlled study.

Methods: Thirty-six junior doctors and final-year medical students were randomly allocated to one of three groups. All received a lecture and video presentation on flexible nasolaryngoscopy. One group received additional tuition using a training mannequin. The last group received mannequin training and feedback on their performance using a video recording. The trainees then undertook flexible nasolaryngoscopy on volunteers with these endoscopies recorded. Blinded observers scored the trainees on a range of objective and subjective measures. The volunteers who were also blinded to the candidates’ training scored the comfort of the procedure.

Results: Adding mannequin training showed a trend toward improvement of performance but did not reach statistical significance. Mannequin training together with video feedback produced significant performance improvement in patient comfort (P = .0065), time to reach the vocal folds (P = .017), and global ability (P = .0006). Inter-rater reliability was excellent with P < .01 in all assessments.

Conclusions: Simulation-based training using an anatomically correct model of the upper airway together with formalized video-assisted feedback on that training is a simple and effective way to improve endoscopy skills prior to starting flexible nasolaryngoscopy on patients.

Key Words: Medical education, simulation, flexible nasolaryngoscopy, airway skills.

Level of Evidence: 1b

Laryngoscope, 124:2034–2038, 2014

INTRODUCTION

Flexible nasolaryngoscopy (FNL) is an important diagnostic tool used by many specialties including otolaryngologists, maxillofacial surgeons, anesthetists, and speech and language therapists. Although FNL is considered a relatively low-risk procedure, it can be difficult to pass the endoscope atraumatically and obtain adequate views of the vocal folds, and the procedure is frequently associated with significant patient discomfort.1

FNL is considered a specialist skill and is not routinely taught in UK medical schools or as a core part of junior doctor training. When otolaryngology trainees are taught this, it is sometimes by lecture, but more commonly, teaching is by practicing on a colleague or in some cases at the bedside, where a patient requiring investigation may be the first experience a doctor gets to pass the endoscope. This exposes the colleague or patient to discomfort and is not necessarily the best way to teach the skills required for FNL.

Simulation and ex vivo training is a rapidly expanding area of surgical education, and over the last decade, procedure simulation by both virtual reality and simple physical models have been shown to improve accuracy and skill, and decrease procedure time, particularly in laparoscopic surgery.2,3 Simulation has an established role in gastrointestinal endoscopy training with studies demonstrating that virtual reality simulation can provide skills transferable to clinical practice as measured by competency scoring, procedure completion rate, performance time, insertion depth, and mucosal visualization.4,5 It can also reduce patient discomfort.6

Physical model simulators have been used in training endoscopic sinus surgery, with even very simple set-ups producing improved post-training performance.7,8 More advanced mannequins have been developed for training in nasendoscopy, intubation, and bronchoscopy, providing a high-fidelity representation of the airway. These are widely available, and as far back as 1988, it was shown that a training regime involving mannequin simulators led to an increased rate of successful fiberoptic nasotracheal intubation.9

Additional Supporting Information may be found in the online version of this article.

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DOI: 10.1002/lary.24699
A realistic human model simulator has been used previously in training for flexible nasendoscopy, and in one study a 15-minute simulator session led to a trend toward shorter procedure time and lower discomfort score, though this trend failed to reach significance. In addition to this lack of evidence to support high-fidelity mannequin models in the teaching of FNL, there are no studies that have addressed the optimum way of using such models. The aim of the current study was to improve the future training of FNL by investigating if mannequins are effective teaching aids, and if video recording of trainee attempts can be used to further improve skill acquisition. A three-armed, single-blinded, randomized controlled trial of teaching techniques, comparing lecture-based instruction with additional mannequin training and mannequin training with video feedback was undertaken.

MATERIALS AND METHODS

Subjects
Candidates consisted of final-year medical students and junior doctors 1 to 2 years post graduation, who were recruited after full disclosure of the study design. None had prior experience performing or observing FNL.

Study Design
A randomized, controlled, study design was utilized with each participant having an equal chance of being allocated to the control (C) group or one of two intervention groups. Participants were randomized with a sealed-envelope technique. The trial was conducted over two sessions, with a single trainer for all groups (M.E.S.). All candidates underwent traditional lecture-based teaching. The control group received no additional training. The other two groups received interventions of mannequin training (MT) or mannequin training with additional video feedback (VF).

Training
Prior to randomization, all candidate groups received a standard 30-minute lecture on the anatomy of the nose and pharynx, and the technique for FNL. This was followed by a video recording of FNL performed on a patient, and an explanation of the equipment. Candidates randomized to the C group left training at this point. Trainees in the two remaining groups received interventions of MT or VF. Mannequin training consisted of individual training on a high-fidelity mannequin simulator (TruCorp Airsim Multi; TruCorp Ltd., Belfast, Northern Ireland). Fiberoptic endoscope (ENF-GP; Olympus Medical Systems, Southend-on-Sea, UK) video images were displayed on a laptop computer using a low-cost modified universal serial bus (USB) camera mounted on the endoscope. Each candidate made two passages of the FNL on a mannequin while receiving guidance during the procedure and verbal feedback afterward.

Candidates in the VF group had the second FNL passage on the mannequin recorded, with individual feedback on technique provided during a review of the recorded FNL examination. The video could be paused to demonstrate anatomy or technical points.

Assessment
All candidates underwent the same assessment procedure. Two volunteers alternately underwent the FNL procedure, with candidates randomly assigned to perform the investigation on one of the volunteers. The volunteer’s nose was prepared in advance of the assessments with xylometazoline hydrochloride 0.1%, but local anesthesia was not administered. A videoscope allowed display on a monitor and recording of assessments (ENF-V2 videoscope, OTV-SI camera system, and Medi-Capture 200 recorder; Olympus Medical Systems). An experienced assessor was present to direct the assessment, assist with scope cleaning, and terminate the assessment if required to prevent harm to the volunteer. Volunteers undergoing the procedure and the assessor were blinded as to the candidates’ training method. Candidates were individually assessed after being directed to visualize the vocal folds. The procedure was considered complete once the vocal folds were clearly seen.

Outcome Measures
After each candidate performed an assessment FNL, the examined volunteer graded discomfort on a visual analogue score (VAS) from 0 to 10 (0 = no discomfort, 10 = unbearable discomfort). Video recordings of the assessment procedures were reviewed by two experienced otolaryngologists who were blinded to the candidates training technique. To assess the speed of the scope passage, the time in seconds to two goals was calculated from the video, using the point of entry into the nostril as a start time. The first goal was to visualize the ipsilateral nasopharynx, and the second was to obtain a steady view of the vocal folds. Candidate videos were further scored using a 1 to 10 Likert-type rating scale (1 = very poor, 10 = excellent) based on control of the endoscope, anatomical awareness in the correct passage for the endoscope, and a global score for ability to complete the task. A Consolidated Standards of Reporting Trials flow diagram of the study is depicted in Figure 1.

Fig. 1. Consolidated Standards of Reporting Trials flow diagram. Candidates were randomized to one of three groups. C = control; MT = mannequin training; PNS = postnasal space; VF = mannequin training with additional individual video feedback.
RESULTS

Thirty-six candidates were recruited, consisting of 23 medical students and 13 junior doctors. The candidates were randomized to produce equal sized training groups. Complete sets of outcome data were obtained for all candidates enrolled, and no endoscopy had to be terminated. These data are presented in Table I and Figure 2.

The VAS results demonstrated a statistically significant difference ($P < .05$, used throughout the trial) in discomfort between the C and VF groups. The MT group was not statistically different in VAS scores from the C group. The results for time to view the postnasal space and vocal folds were similar, with a statistically significant difference between only the C and VF groups.

There was a statistical difference between the C and MT groups, and the C and VF groups for rater-assessed control of the endoscope, but only the C and VF groups differed for assessed anatomical awareness and global ability.

Inter-rater reliability was found to be very good, with no significant difference found by Spearman rank test for the recorded timing points or ratings ($P < .01$ in all assessments). No statistical difference was found between the performance of medical students and junior doctors in any of the groups.

DISCUSSION

Given a worldwide trend toward simulation in medical and surgical training, it is important to explore how simulation techniques are best used to facilitate training, both in terms of the type of simulation and its implementation. This study demonstrates that a simple simulation exercise using a mannequin model can provide transferable skills in FNL that will benefit patients and trainees.

In this study mannequin simulation with video feedback significantly reduced the time to reach key anatomical points in FNL examination, improved rater-assessed skill, and reduced patient discomfort. Previously, training for FNL using a model was suspected to improve examination speed and patient comfort, but findings have not been statistically significant.\textsuperscript{10} We have demonstrated that mannequin training alone may not be sufficient as a training method for FNL, as only the group that received video feedback had consistently improved performance across all outcome measures.

No trial has previously been conducted looking at the effect of feedback in training for FNL, but the use of feedback has been investigated elsewhere, and its importance in clinical training is well established.\textsuperscript{12} Formal feedback during simulation can significantly improve subsequent procedure performance in colonoscopy training,$^{13}$ and reduce the time and repetitions required to achieve a predefined proficiency level in laparoscopic training.$^{14}$ Closed-circuit video has been used in training various types of endoscopy and intubation for some time,$^{15,16}$ though its use as a feedback tool has not been formally investigated.

When watching the video recording, candidates are able to analyze their movements, consider their performance, and receive feedback after the event. This may be more beneficial than feedback during the procedure, because the trainees are more relaxed and not focusing on motor skills. The video review session with feedback used in this study is ideal when training for shorter procedures, though the technique may be transferable to gastrointestinal endoscopy or laparoscopic simulators, and can be used with physical models or virtual reality systems.

With the mannequin training and video feedback for FNL, the trainees started performing the procedure on volunteers at a higher level of skill. This should enable subsequent training to focus on perfecting the technique and identifying pathological changes in the upper airway. This is time efficient, and should allow faster progression of trainees to a stage of independent practice. The mannequin also provides a risk-free environment for trainees to practice FNL skills, without the stress or potential for harm that comes with performing the procedure for the first time on a colleague or patient.
Within each training group we found no significant difference in outcomes between the students and junior doctors undergoing the training. This suggests previous experience of other procedures is not important, and the training is of benefit to a wide range of trainees, either at medical school or later specialty training.

There is a movement toward competency-based surgical training, and like other forms of simulation,17 in the setting of a training program, the mannequin may provide a method of assessment. However, before this occurs, studies would need to validate the method demonstrating a correlation between mannequin and human performance.

The simulator training method used in this study is potentially cost-effective and time efficient. After receiving a group lecture, each candidate undergoing practice with video feedback required <10 minutes tuition. It would have been possible to have undertaken the training using the same high-quality video equipment that was used for the assessment. However, it was decided that an inexpensive modified USB camera attached to the endoscope should be used to keep setup costs low. Assuming that endoscopes and light sources are available, the only substantial cost is the mannequin, though this type of high-fidelity model may not be essential. Another study has compared high-fidelity mannequin trainers to simple nonanatomic analogues, and found that there was no difference in subsequent human volunteer pass times.18 This may suggest that less expensive and readily available equipment could be used in the training, making the setup widely achievable.

A Cochrane review on the topic of gastrointestinal endoscopy6 showed that simulation-based training, as compared with no training, provides participants with some advantage over their untrained peers, but there was no conclusive evidence that simulation-based training was superior to conventional patient-based teaching. Video feedback could be used equally well in patient-based training, and it would be interesting to go on to compare the efficacy of this technique with the use of models.

**CONCLUSION**

Simulation of FNL using a high-fidelity mannequin model can improve performance when performing the procedure on humans, but only when additional feedback is provided. Simulation is a developing field that can augment current one-to-one training on patients, allowing early skill acquisition and improving patient comfort and safety. Increasingly, simulation is incorporated into training programs, and these must focus on the associated teaching and feedback if optimum results are to be achieved.

**Acknowledgments**

The authors thank Olympus Medical Systems UK for supporting the trial through the loan of flexible endoscopes and video recording equipment. The authors also thank Professor Ray Meddis at Essex University for advice regarding analysis of the results.

**BIBLIOGRAPHY**


