LEARNING FIBROOPTIC INTUBATION: USE OF SIMULATORS V. TRADITIONAL TEACHING

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A graduated training programme developed to facilitate learning of nasotracheal intubation using flexible fiberoptic endoscopes has been described in detail [1]. The programme was developed to provide a means of overcoming the apparent reluctance of established clinicians, and trainees, to attempt a new technique associated with a high incidence of failure. It was based on current educational principles for teaching and learning a psychomotor skill [2-4], and included graduated learning objectives, and both model and live patient simulators.

Several factors suggested that the programme was highly successful: the high success rate (74 successful intubations out of the 75 attempted); the short average time for intubation upon completion of the programme (average 3.3 min); the high incidence of patient satisfaction; and the highly positive regard in which the trainees held the programme. Although a number of reports of the use of various types of models as simulators have appeared in the medical education literature over the past 15 years [5—15], few have included the use of control groups and randomized assignment of trainees [5,7,11] to document their true value. Although these three studies documented the value of the simulators, in one [5] the simulator was a sophisticated computer-controlled anthropometric manikin, while in another [11] the learners demonstrated their improved performance on the simulator itself, not on patients in the “real world” of clinical practice.

This study was undertaken to evaluate this graduated training programme, by assessing the effectiveness of learning on simulators before an unassisted fiberoptic intubation was attempted in the operating theatre. It compared the success of the initial attempts to perform fiberoptic intubation in patients in the operating theatre between two groups of randomly selected anaesthesia trainees. It seems reasonable to conclude that a learner’s initial attempts at a new technique are the most hazardous for the patients and the most stressful, not only for the learners and their teachers, but also for established clinicians who

SUMMARY

This study compared a graduated training programme with that of a traditional teaching method to facilitate the learning of the technique of fiberoptic nasotracheal intubation. Thirty-two anaesthesia trainees were randomly assigned to two groups. The graduated programme involved: practice on a bronchoscopy teaching model; exposure of the epiglottis and vocal cords in patients recovering from general anaesthesia; performance of fiberoptic nasotracheal intubation in awake sedated patients. The traditional programme involved: demonstration (on a patient) of one fiberoptic nasotracheal intubation by the instructor; performance of fiberoptic nasotracheal intubation (by the trainee) in awake sedated patients. Nasotracheal intubation was accomplished significantly more often by the trainees in the graduated programme (86 out of 96 (89.6%) v. 64 out of 96 (66.5%) (P < 0.01). The results demonstrate that trainees who undergo a graduated training programme using simulators are initially more successful at awake fiberoptic nasotracheal intubation than those who have learned in the traditional manner, and that the conditions of the investigation were acceptable to the trainees and patients.
are teaching themselves. The study group underwent the graduated programme, while the control group learned from a traditional “see one, do one” teaching method.

MATERIALS AND METHODS
Twenty-eight anaesthesia residents and four oral surgery residents rotating through the Anesthesia Service participated in the study. They were randomly assigned by use of a random number table either to the experimental group which entered the graduated training programme or to the control group which received traditional teaching on patients in the operating theatre.

(A) The graduated training programme consisted of three phases after demonstration of the fibreoptic laryngoscope (Machida America Inc. Model FLS-6-50) by the instructor, and has been described in detail previously [1]: (1) Model simulator; practice on bronchoscopy teaching model. (2) Live patient simulator; exposure of epiglottis and vocal cords in patients who had given informed consent and who were recovering from general anaesthesia in the recovery room. (3) Fibreoptic nasotracheal intubation in six awake sedated patients in whom such intubation was indicated. The time from the introduction of the fibrescope into the tracheal tube to completion of intubation was recorded with a stop watch. If the trainee failed to expose the vocal cords within 4 min, the intubation was considered failed, and verbal comments and directions were given. If the vocal cords were not located within the next 2–3 min the instructor exposed them and the trainee completed the intubation.

(B) The traditional teaching method consisted of two phases after demonstration of the fibreoptic laryngoscope by the instructor: (1) Demonstration of one fibreoptic nasotracheal intubation. After assisting with the sedation and performance of topical anaesthesia, the instructor described the technique in detail and demonstrated the anatomical landmarks through the fibrescope while performing the endoscopy. (2) Fibreoptic nasotracheal intubation in six awake sedated patients in whom such intubation was indicated.

In order to compare the rate of successful intubation in the two groups, each trainee was assigned a single score equal to the number of successful intubations s/he performed out of the six attempts at intubation. The scores for all the trainees were then treated as ordinal data and the two groups were compared using the Mann–Whitney U test. The null hypothesis that there was no difference between the two groups was to be rejected if \( P < 0.05 \). Two additional supporting numerical comparisons, between the performance of the two groups on their first six attempts at intubation, were used, without additional statistical tests to avoid the beta-type error inherent in the use of multiple such tests on the same data: (1) Percentage of trainees successful in all intubation attempts. (2) Percentage of instances in which the instructor had to expose the vocal cords. All trainees were interviewed on completion of their training, and postoperative visits were conducted on all patients in whom the trachea had been intubated.

RESULTS
The age distribution, American Society of Anesthesiologists’ physical status classification, indication for fibreoptic nasotracheal intubation and type of operation, were similar in the two groups of patients. The duration of anaesthesia training before attempting the first fibreoptic intubation in the experimental group averaged 7.4 months (range 2–22 months), compared with 8.5 months (range 1.5–20.5 months) in the control group. There were 11 male and five female trainees in the experimental group, and 10 male and six female trainees in the control group. The number of dentists in each group was three and one, respectively.

The experimental group took an average of 6.5 h to complete this programme: 1 h for the demonstration by the instructor of both the equipment and use of the model; an estimated 2 h for practising on the model without the instructor; 1.5 h for six laryngeal exposures; 2 h for six actual intubations. The control group took an average of 3.5 h: 1 h for a demonstration of equipment; 0.5 h for the demonstration of one

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<td>9</td>
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intubation; 2 h for six actual intubations. The time spent by the instructor in teaching averaged 4.5 h for each trainee in the experimental group and 3.5 h for each trainee in the control group. The major difference between the groups was the 3.5 h spent by each trainee in the experimental group in practising psychomotor skills on simulators before attempting an intubation in a patient in the operating theatre. In place of this the control group watched a demonstration lasting 0.5 h before attempting an intubation in a patient. This is the method traditionally used by anaesthetists when teaching psychomotor skills.

The trainees in the experimental group were successful in 86 out of the 96 (89.6%) intubation attempts; the trainees in the control group were successful in 64 out of the 96 (66.5%) intubation attempts. A comparison of the number of successful intubations performed by each trainee is displayed in Table I. The Mann-Whitney U test gave a value of \( P < 0.01 \), and resulted in rejection of the null hypothesis. This was supported by both of the additional numerical comparisons. In the experimental group nine of 16 (56.2%) trainees were successful in all six actual intubations, while in the control group three of 16 (18.8%) trainees were successful in all six intubations. In only one out of 96 intubation attempts (1%) in the experimental group did the instructor have to identify the cords. In the control group the instructor had to identify the vocal cords on 14 occasions (14.6%).

The interviews with the trainees in the experimental group indicated that, subjectively, they felt that the training on the model, and on patients recovering from general anaesthesia, had been helpful. Four indicated that the time spent on the model and in the recovery room could be reduced; only two indicated a need to perform more intubations, and one felt the pressure of being timed in the operating room. Their comments on the weaknesses of the programme were focused primarily on the need to obtain informed consent. Five trainees in the control group indicated that they were “not comfortable” using the fibrescope. Three felt the pressure of being timed in the operating room, three indicated that they would have liked to have worked on the model and to have experience on patients in the recovery room, and three indicated that they would have benefited from more experience of intubation. The post-operative visits (after all 192 intubation attempts) revealed that 75 (39%) patients had recall, but that although seven found the procedure unpleasant because of pain during the passage of the tube through the nares, only three would prefer not to undergo it again. These few complaints were voiced by the patients of both group of trainees.

**DISCUSSION**

As none of the trainees in the experimental group had had previous exposure to fiberoptic intubation, compared with two trainees in the control group who, after completion of their training, indicated that they had limited experience with flexible fiberoptic bronchoscopes, the better performance of the experimental group on their initial attempts to perform fiberoptic intubation on patients in the operating theatre can be attributed to the graduated training programme, and the 3.5 h spent learning and practising psychomotor skills on the simulators. Support for, but not additional proof of these data, stems from two observations. First, the instructors’ routine observations suggested that trainees in the experimental group demonstrated more confidence and were more skilful in handling the fibrescope. Second, clear communication between the instructor and the experimental group of trainees was easily established while with the control group it was difficult to establish because of the latter group’s lack of familiarity with the instrument and of the actual technique of fiberoptic intubation. Trainees in the control group often had to be reminded of the steps, and shown how to hold the instrument and use the control knob.

The advantages of this graduated training programme appear to be: every anaesthetist can follow the steps and so train himself or herself in the use of these instruments; the ability to hold and manipulate the fibrescope and to appreciate the view through it can be learned with unlimited time on an artificial model; exposure of the vocal cords in patients recovering from general anaesthesia provides a convenient and non-stressful environment for gaining experience in the use of the fibrescope in humans, for identification of laryngeal structures, and for recognizing the problems created by secretions; the experience gained by exposing the larynx in the recovery room also generates the confidence in the trainee which is a critical factor for success in the first patient for whom it is used in the operating theatre; having learned the basics of the psycho-
motor skill on simulators, the learner can concentrate on perfecting his/her technique in patients, and thereby make more efficient use of the limited number of such patients who are available; the prior experience gained from the simulators should minimize the time taken to acquire an adequate level of skill, and decrease the risk inherent in learning from scratch on patients in the "real world" of clinical practice; the reactions of both the residents and the patients indicate a high degree of acceptability.

The disadvantages of this graduated training programme appear to be the additional 3 h of work undertaken by the trainees before they attempted to intubate a patient in the theatre environment; the additional 1 h spent by the instructor in teaching the trainees; the need to obtain the informed consent of the patients who would act as "simulators" while recovering from general anaesthesia.

Clearly, it is as difficult for an established clinician with no previous training in fibreoptic endoscopy to introduce the technique into his/her practice as it is for an anaesthesia trainee to learn the skill. It is also clear that, even if an expert instructor is available (as in training programmes), there are numerical limitations to providing extensive training by utilizing only patients in the operating theatre. We believe this study documents the effectiveness of learning on simulators before an unassisted fibreoptic intubation is attempted in the operating theatre and, therefore, provides a solution to both of the above educational problems.

In summary, this programme affords the learner, including the established clinician attempting to teach him/herself, ample opportunity to practise the various parts of the skill in increasingly more complex circumstances by utilizing simulators. It culminates in a high rate of success when the learners first attempt to perform unassisted fibreoptic intubations in patients in the operating theatre. In addition, the limited number of patients available who require such a technique can be utilized more efficiently.

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REFERENCES