Acquisition and Maintenance of Endoscopic Skills: Developing an endoscopic dexterity training system for anesthesiologists

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Abstract

The acquisition and maintenance of essential psychomotor skills that are only required sporadically is a significant problem in medical training and practice. It is of particular relevance to anesthesiologists with regard to fibreoptic intubation, a technique that may be under-utilized despite its central role in the management of the difficult airway. Dexterity deficit due to current training models, dexterity decay due to lack of practice, and situational stress related to the clinical environment may combine to impede effective training and confident use of endoscopes in airway management. An educational resource (Dexter™) has been developed to overcome these problems. Dexter is a non-anatomical, endoscopic dexterity training system designed to encourage practice and help establish and maintain a state of procedural readiness, even if clinical exposure to difficult airway situations is sporadic.

Key Words

Dexterity, Endoscopy, Difficult airway, Fibreoptic Intubation, Psychomotor skill training

Conflict of Interest Declaration

The authors have disclosed a commercial interest in the training system described in this article

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Introduction

The difficult airway remains among the greatest clinical concerns of most anesthesiologists and among the most common causes of serious anesthesia related morbidity and mortality.[1-4] The role of fibreoptic intubation in situations of both recognized and unrecognized difficult intubation is well established.[5-8] The requirement for fibreoptic equipment, trained personnel and for the teaching of trainees and staff is internationally acknowledged[9,10] and highlighted by accreditation,[11] audit [3] and professional bodies.[5]

Fibreoptic intubation has become a standard of practice and numerous educational resources are available, detailing relevant patient management, anatomy, endoscopic techniques and equipment.[7,12-15] Training programs at several institutions have been described.[7,14] Workshops associated with special interest groups, institutions and international conferences are common. Simple models and "homemade" endoscopic obstacle courses have been described[16-18] and a variety of anatomic manakins are available.

Despite the widespread awareness of fibreoptic intubation as the technique of choice in many difficult airway situations, this powerful technique remains under-utilized.[1,3] The Australian Incident Monitoring Study[1] reported "poor assessment of the airway" as the most common preoperative contributing factor to a subsequent critical incident. Of 23 known or suspected difficult airways, "…in the majority of cases a 'standard' anaesthetic technique was used rather than one more appropriate for this situation. Planned use of awake fibreoptic intubation was uncommon." Few anesthesiologists actively maintain their skills and only a minority of teaching programs formally teach their trainees endoscopic techniques.[8, 19,20,21]

This article suggests reasons for the under-utilization of a recommended technique and describes an educational resource (Dexter™) designed to overcome these problems. A controlled trial is currently underway at the first author's institution and trials are planned or underway at other sites internationally (personal communication).

Learning a Psychomotor Skill

The essential components of successful endoscopy are patient management, anatomy recognition and dexterity. Aspects of patient management such as patient selection and preparation, and relevant medical knowledge, are typically learned at a cognitive level. Endoscopic dexterity, however, is primarily a psychomotor skill requiring considerable hand-eye co-ordination. Consistent, skilled performance requires not only cognitive awareness but also directed "hands on" learning combined with ongoing practical application.

Regardless of natural ability, any individual will require time in an appropriate environment to acquire and refine a psychomotor skill. However, the clinical environment imposes numerous barriers and may not be the best place to develop dexterity. Bench practice and subsequent skill transfer to patients has been successfully demonstrated and should form part of a structured program for psychomotor skill training[18].

Why are endoscopes under-utilized?

While endoscopes represent a significant capital expense for many anesthesia departments, surveys in first world countries indicate that fibreoptic intubation is "limited more by lack of expertise than lack of equipment."[14 ,19] The psychomotor component of endoscopic airway management is recognized as the hardest to learn and the easiest to lose.[9,10] The related concepts can be thought of as dexterity deficit and dexterity decay.

Dexterity deficit

Anatomic models and patients with normal anatomy play an important role in the teaching of airway endoscopy but may detract from the development of endoscopic dexterity.

The normal airway is a predominantly midline structure and endoscopy occurs mostly in a single vertical plane. The essential skill of rotation to allow accurate oblique movement of the endoscope tip is easily neglected. Anatomic models are characterised by fixed anatomy and a large constant air space. The constraints of the clinical environment are reduced but endoscopy requires only basic levels of dexterity. The models are designed to represent anatomy rather than develop the skill components of endoscopic dexterity.

Non-anatomic bench models have been described in response to these limitations.[16-18] Successful skill transfer to the clinical environment has been demonstrated after practice on a model with an expert instructor.[18] The models are simple and are described in a manner that allows them to be re-produced if they are not commercially available. Typically they involve manipulating the endoscope tip through a series of holes or around obstacles that are under cover or contained in a box.

Limitations of currently described models include narrow learning objectives, fixed design and lack of a supporting training system. The homemade varieties are unsuitable for sustained professional use. Simple models with fixed endoscopic landscapes may diminish breadth of learning and incentive for practice.

Dexterity Decay

The ability to perform an essential skill at short notice requires practice. If not actively maintained, skill level or “touch” will decay. While opportunities exist for the highly motivated, the average clinical environment is not conducive to effective practice and participation in an endoscopy workshop is of limited help when confronted with a difficult intubation some months later. Most anesthesiologists encounter difficult airways sporadically and sometimes unexpectedly. They may perform fibreoptic intubation only occasionally or be inhibited by the possibility of difficulty or failure. Reluctance to use the technique distorts currently accepted principles of airway management.

Several authors have stressed the importance of practice.[9,10,16] The determinants of practice also need consideration. These include incentive, opportunity and reward.

Incentives include interest, enjoyment, relevance and structure. If motivation is provided then educational objectives can be achieved as a secondary gain. Because skilled teachers are a finite resource and cannot be constantly available, an educational structure for self-tuition and practice needs to be provided.

Affordability and accessibility of training systems are vital for opportunity to practice. Skill stations can be a continuously available educational resource if brought out of the workshop and into the anesthesiology department. Human patient simulators and virtual endoscopy trainers represent significant educational developments but are large budget items that are not routinely available to the great majority of anesthesiologists.

Short-term rewards of practice should include enjoyment and satisfaction. Anticipated long-term rewards include confidence, skill transfer, procedural readiness and performance.
Dexterity deficit and dexterity decay may declare themselves in the clinical setting when anatomic variations or pathology need to be negotiated accurately and efficiently. These are of course the very situations for which the

intubating bronchoscope is most valuable. Rectifying these problems requires effective learning and ongoing practice.

Designing a solution

Our goal was to develop an endoscopic dexterity training system that would overcome the described barriers to effective endoscopy by anesthesiologists.

Dexter is a non-anatomical, endoscopic dexterity training system. It provides a structured tool for psychomotor skill training as well as motivation for practice in a non-clinical setting. It allows the separation of psychomotor skill training from the other essential components of endoscopic airway management.

With reference to existing non-anatomical trainers, Dexter was designed to meet a wider range of educational objectives. An integrated training program was developed to provide structured learning, feedback, incentive for practice and capacity for self tuition. These design features are described below.

Dexter is non-anatomical and modular. Unique mechanisms can therefore be invented to achieve specific learning objectives. The modular design provides a variable endoscopic landscape intended to stimulate interest, prevent model recognition, allow multiple levels of difficulty and anticipate future development.

The system components include a manakin, an image chart, a series of maps and a structured training manual. The objective is to explore the manakin endoscopically and find the images placed inside it. These are identified from the image chart, and a letter corresponding to the image is written in the correct location on the appropriate map (Fig 1).

The modular internal components include Y pieces, image caps and pods (Fig 2). The Y pieces click together and pull apart to create various branching patterns that determine the overall configuration. Image caps are inserted into the Ys in different planes. Images were selected or designed not only to promote interest and enthusiasm but also to achieve specific objectives e.g. skills related to orientation, pattern recognition and scale. Components rotate on each other allowing variation in the overall configuration, the axis of consecutive Y pieces and the location and orientation of images. Internal angles are rounded and internal surfaces are smooth to minimize potential for endoscope damage.

In a novice training exercise, the participant enters a simple conduit from the upper opening and advances the endoscope to the first image, a process that requires little dexterity. Tip flexion is required to see the first vertically opposed images. Handle rotation is required to negotiate the first bifurcation. The participant then learns to combine the basic endoscopic movements of tip flexion, handle rotation and cord advancement to achieve accurate oblique movement. This pattern is reinforced in subsequent exercises such that the movements should start to occur without conscious effort.

The lower opening enters into a more complex area before the images are encountered. This is used to emphasize the principles of endoscopic control in larger spaces. The navigation pod contains a series of diaphragms with eccentric apertures that can be rotated, thus creating a variable "slalom course" for the development of fine endoscopic movements. The image pod is used for exercises related to larger images, field of view, orientation and the effects of changing endoscopist position.

Unlike simple bench models, Dexter is supported by a structured educational system in the form of a training manual. This comprises cognitive, psychomotor skill training and practice sections. The cognitive component is a primer of endoscopy detailing the optical and mechanical characteristics of endoscopes.

The skill training section comprises a series of modules and accompanying exercises with specific learning objectives e.g. basic movements, navigation, image recognition, orientation, mental mapping, scale and distance. Each exercise is accompanied by a commentary to assist teaching or as a companion guide for self-tuition, as well as points of safety and clinical relevance. The training modules progress from novice exercises to advanced dexterity. Internal configurations and their corresponding maps are described for each exercise. The mapping of each configuration provides the feedback essential for educational power and ensures active driving of the endoscope rather than “sight-seeing”.

The third section provides examples of game plans for practice, competition, assessment and workshops. Game plans provide cognitive challenges and entertainment to stimulate interest and practice while maintaining psychomotor skills.

Dexter has been used at airway courses in New Zealand, Australia, the United Kingdom, North America, Asia and South Africa. It has been exhibited at the IARS 2000 (First Place Scientific Exhibits) and PGA 2000 (Best Instructional Exhibit). Feedback from anesthesiologists at other institutions and exhibits is enthusiastic and Dexter is consistently identified as the most valuable skill station on audit of the advanced airway course at the first author’s institution. It is part of an endoscopy practice station permanently located in that anesthesiology department.

A pilot study as a precursor to formal evaluation has been performed. Novice endoscopists took approximately 3.5 hours to complete the training modules. Performance measurements on anatomic models before and after dexterity training showed improvements in time to achieve set tasks in the range of 25-46% and the mean time to perform clinical endoscopy (mouth to carina) on awake subjects (5 attempts each) after non-anatomic training was 32 seconds. While no conclusions can be drawn from the pilot study, the findings are consistent with local experience and useful for formal study design. Formal evaluation has begun to measure Dexter’s effectiveness as a training tool for the clinical environment and to assess its role in a structured training program at this institution.

The ability to alter the internal configuration and endoscopic landscape while maintaining a selected level of complexity suggests a role for Dexter as a psychomotor assessment tool in research settings. Modifications under development make Dexter also suitable for endoscopy training in other medical specialties.

Conclusion

Dexterity deficit and dexterity decay undermine the psychomotor component of fibreoptic intubation and contribute to the under-utilization of this recommended technique. An endoscopic dexterity training system, Dexter, has been developed to address these problems. It is modular, non-anatomic and supported by a structured training system. It is intended for both workshop and departmental environments and levels of skill from novice to expert. It is expected that Dexter will assist the widespread and skilled use of endoscopes in airway management leading to an improvement in patient care and efficient use of hospital operating time.

Legend for Illustrations

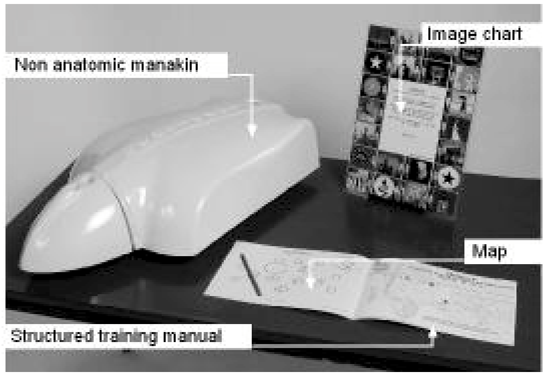

Figure 1: Dexter. An Endoscopic Dexterity Training System

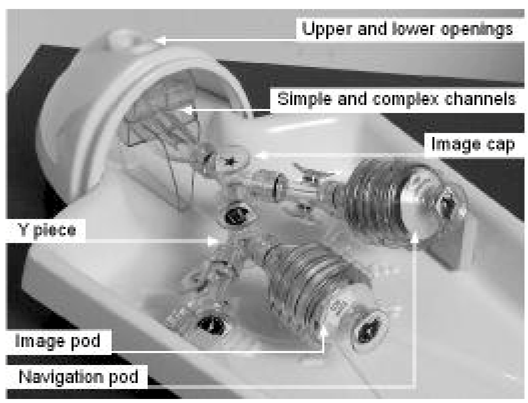

Figure 2: Dexter. Internal Components

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