Teaching and training in fibreoptic bronchoscope-guided endotracheal Intubation

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ABSTRACT
Fibreoptic-guided endotracheal intubation skill is a strongly desirable attribute of an anaesthesiologist, essential to deal with difficult airway situations. Facilities for formal training in this crucial area are limited. Various aspects of the available and desirable training in fibreoptic endoscopic skills are discussed.

Key words: Difficult airway, fibreoptic airway management, fibreoptic-guided endotracheal intubation

INTRODUCTION
It is widely accepted that fibreoptic-guided intubation (FOI) is considered as “gold standard” of difficult airway (DA) management. In a patient with DA, fibreoptic bronchoscope, or more appropriately called intubating fibreoscope, is used to perform endotracheal intubation both by direct and indirect techniques. Fibreoptic airway management (FAM) has a definite place in the DA algorithms of various professional bodies.[1,2] Success largely depends on the skill and experience of the anaesthesiologist. Different aspects of the teaching and training of FAM, especially in the Indian context, are discussed in this article.

BACKGROUND
Although the fibreoptic bronchoscope (FOB) was designed and developed in 1966, the first fibreoptic nasotracheal intubation was performed with a fibreoptic choledoscope in a patient with Still’s disease.[3,4] FOB was first used 5 years later for intubation of patients with rheumatoid arthritis. Stiles and colleagues reported use of FOI in 100 patients in 1972.[5] Subsequently, use of FOB was expanded to various aspects of airway management such as confirmation of proper placement of single- and double-lumen tubes, evaluation of airway pathology pre-operatively as well as in the intensive care unit, DA management in both adults and children, etc. FOB has also been used for indirect techniques of endotracheal intubation, such as intubation through laryngeal mask airway, use of introducers, retrograde techniques and so on.

Along with the development of the FOB and wide range of accessories, importance of training the anaesthesiologists in the skill was realized and various methods of training were evaluated. They include didactic lectures, workshops with hands-on training on the patients under supervision, use of airway training mannequins, simulators, virtual reality trainers and cadavers.

Need for training
In spite of its important role in airway management,
FAM skills are not routinely taught during the training program due to various reasons such as non-availability of the fibroscope, trainers and, lastly, suitable patients. In many institutions, the instrument is in the custody of chest physicians, ENT surgeons or cardiothoracic surgeons on whom the anaesthesiologist has to depend for intubating a patient with anticipated DA.

India has a large population and has made rapid strides in the medical field, so much so that medical tourism is on the rise. This results in an ever-increasing number and variety of DA in patients coming for increasingly complex surgical procedures, including cosmetic procedures. It becomes imperative that the anaesthesiologist keeps abreast with standards of care and core techniques in DA management as much as in other aspects of anaesthetic management. Development of FAM skills enhances the ability of the anaesthesiologist to manage many of the anticipated and even unanticipated DA situations with confidence and without endangering the safety of the patient. It reduces the number of attempts, time required for intubation, incidence of airway injuries and risk of aspirations and helps to avoid need for surgical airway. In addition, FOB is useful for airway management in the intensive care unit as well. Here, an anaesthesiologist experienced with FAM can perform diagnostic bronchoscopy and clear the secretions as well.

What should be taught?
An affective training program should help in acquiring technical skills along with the requisite clinical and theoretical knowledge of the patient and the instrument. The following topics should be included in any FAM training program:

1. Knowledge of the equipment: FOB (sizes, appropriate tube sizes, basic physics, parts, movement, attachments, preparation, care and sterilization), accessories including camera and monitors. Portable battery and disposable version of FOB are the recent developments.
2. Indications, contraindications, advantages and disadvantages of FAM.
3. Preparation of the patient, including local anaesthesia of the airway.
4. Direct fiberoptic nasotracheal and oral intubation.
5. Alternate or indirect techniques of FOI. The most important is fibroscopic-assisted intubation through different types of laryngeal mask airway (LMA).

Methods of training
Practice of FAM involves development and execution of a set of complex cognitive, psychomotor and judgmental skills along with sound clinical knowledge. It can be developed by different training methods.[5-7]

Workshop
Workshop provides focused learning opportunity for a predefined group of delegates. It consists of lectures, panel discussions and hands-on training. Video of the FOI also can be used to reinforce learning. Using a pre-test and evaluation at the end provides objective assessment of the outcome to some extent. It also helps to find out the deficiency of the program, which can be corrected in the subsequent ones. The main disadvantage is that there is no way of evaluating the outcome.

Training in the department
Training in the department by experienced staff is the most effective method. This provides a better learning environment because of the familiarity, better trainer to trainee ratio and absence of time limit. But, the ethical correctness of subjecting a patient to a procedure by a novice has been questioned.[8] Also, the pressure by surgical colleagues and management for quick “turnover” of patients will have a negative impact on the learning. Varying periods of practice in the manikins or different types of specialized airway trainers (see below) have been found to enhance the effectiveness of learning and to improve the outcome.[9-11]

Structured fiberoptic training course
Structured fiberoptic training course is an effective way where the candidates are taught “step-by-step” FAM skills, beginning with an explanation about the instrument, movements required, etc., proceeding to practice on manikins or trainers and, finally, performing FOI on patients under supervision. Details of such a course started at the author’s institution are presented in Appendix 1.

Oxford fiberoptic training program
Oxford fiberoptic training program consists of a pre-clinical module or clinical module. The former includes introduction and demonstration of equipment, discussions on techniques, video demonstrations and practice sessions on the “Oxford Fiberoptic Teaching Box” [Figure 1] and manikins. The clinical module consists of practice of oral and nasal fiberoptic endoscopy in anaesthetized patients with
normal airway, demonstration of airway anaesthesia and sedation and, finally, supervised practice on patients with DA.

Use of airway training equipment and cadavers for learning

Airway trainers have been found to be effective in learning the FAM skills. Most commonly available and least expensive are simple airway training mannequins. It is rugged and allows practicing both nasal and oral intubation. Unlike the advanced trainers, it does not simulate the characteristics of a normal airway.

Choose-the-hole model

Choose-the-hole model is a simple model that can be developed locally [Figure 2]. It was designed by Dr Arthur Frederic David Cole of the University of Toronto, Canada.\(^{12,13}\) Three wooden panels with holes are mounted on a wooden base. Syringe barrels are inserted into the holes in different combinations. This is simple and inexpensive non-anatomical model for improving manipulation skills. It can be designed locally in any institution. Naik et al.\(^{14}\) studied that the fibreoptic manipulations learnt on this model can be transferred to clinical settings. First-year anaesthesia and first- and second-year anaesthesia residents were recruited and were devided to receive didactic lectures or training on the above model before they were evaluated on their fibreoptic intubation skills on anaesthetized paralyzed apnoeic patients. They concluded that the skill developed on the model was transferred to clinical scenarios, although this type of training alone is not sufficient.

High-fidelity systems

They are expensive but can create a more realistic environment. Multiple types of clinical situations can be simulated and can be repeated. In addition, a wide range of data and pictures can be automatically recorded and stored. This enables review and assessment by blinded observers leading to a more objective evaluation. One example is "The AccuTouch Bronchoscopy Simulator" (Immerson Medical, Gaithersberg, MD, USA), which has an in-built comprehensive software capable of creating multiple clinical scenarios. In an observational study, Goldmann and Steinfeldt\(^{15}\) showed that this system can be used to effectively train and evaluate the trainees, and advocated further studies. In this study, there was no comparison to performing FOI in actual patients.

### Appendix 1: Fiberoptic airway management training program at K S Hegde Medical Academy

| Duration: 6 days |
|------------------|
| **Day 1**        |
| Pretest: Know your equipment |
| Details of fiberoptic bronchoscope, its parts and accessories, attachments, handling, disinfection, care and cleaning after use and movements |
| **Day 2**        |
| Use of FOB on manikin: Nasal and oral route |
| **Day 3**        |
| Practice on manikin, Demonstration of FOB use in a normal adult airway |
| Anaesthetized patient (Orotracheal and Nasotracheal intubation) |
| Use of fiberoptic with LMA and other indirect methods |
| **Day 4**        |
| Practice on manikin, Local anaesthesia of upper airway for use of FOB in awake patient (Oral route and Nasal route) + Fiberoptic endoscopy |
| Normal patients without intubation limiting only to visualization of the glottis |
| **Day 5 and 6**  |
| Supervised FOB guided intubation in adults |
| Conclusion and evaluation |

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Figure 1: Oxford fibreoptic teaching box

Figure 2: Choose-the-hole model
Dexter™ [Figure 3] is an endoscopic dexterity system is another non-anatomical model for developing fibreoptic skills. Studies have shown\(^{[16,17]}\) a correlation between endoscopic performance on this model and subsequent clinical performance. A study by Chandra et al.\(^{[18]}\) found no added benefit of training in a high-fidelity model with respect to transfer of FOI skills to clinical situations.

Cadevers have been used for learning various clinical skills in anaesthesia, including assessment of FOB.\(^{[15]}\) The advantages include similarity to human airway, lack of time restriction and ability to be used by a more number of trainees.

**Volunteers and surgical patients**

Studies of training and assessment of FAM have been performed on human volunteers, including a group of delegates who were themselves trainees\(^{[19-23]}\) Anaesthetized patients should be used for FOI only after adequate practice on non-human training modules. Fibreoptic intubation was found to be safe in both anaesthetized spontaneously breathing and paralyzed apnoic patients when performed by trainees. FOI can also be performed in awake patients with local anaesthesia with or without sedation. Local ethical committee clearance will be required for use of patients or volunteers. Whether there is a need for separate consent for FOI is controversial.

**Evaluation**

Both objective and subjective evaluations are required when FAM skills are assessed. Most commonly used is the Global Rating Score, which has been recently modified\(^{[14]}\) to make it more objective. A GRS score (Appendix 2) of 3 is required to consider a trainee as proficient. Also, checklists are available for assessing the performance (Appendix 3).

**SUMMARY**

There are no definite established standards for training in fibreoptic training programs. A felt need is to establish a well-structured training program with specific goals and objectives. Developing centres for FOI training helps in achieving excellence over a period of time. The secondary goal of the recognised centre should be to develop trainers as well.

Initial training is imparted as a preclinical module followed by a clinical module incorporating all the aspects of training. Low- and high-fidelity models are available for practice. After adequate training in vitro and evaluation, trainees can perform FOI in awake or anaesthetized patients under supervision in patients with normal airway. GRS is the most commonly used

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**Appendix 2: Five points grs of fibreoptic bronchoscope manipulation ability**

| View of central airway | Frequently loss view of central airway | – Loss of view of central airway of no more than once | – Maintains central airway in center of field of view |
|------------------------|----------------------------------------|---------------------------------------------------|--------------------------------------------------|
| Mucosal contact | Frequent or hard collision with mucosa | – No collisions, infrequent glancing contact with mucosa | – No mucosal contact |
| Progress | Hesitant, jerky or inaccurate attempts to progress | – General progression, occasional hesitancy, some inaccuracy with initial movement | – Progresses smoothly and accurately between sequential landmarks |
| Orientation | Image not oriented | – Image usually oriented | – Maintains orientation |

**Appendix 3: Checklist for intraoperative fibreoptic orotracheal intubation performance**

| Task | Correctly | Incorrect |
|------|-----------|-----------|
| Hold control section in one hand with thumb | ☐ | ☐ |
| Positioned for flexion and extension control and index finger for suction | ☐ | ☐ |
| Focuses scope using appropriate external object | ☐ | ☐ |
| Controls tip of scope with other hand | ☐ | ☐ |
| Introduces bronchoscope into mouth centered | ☐ | ☐ |
| Maneuvers bronchoscope through oropharynx and visualizes vocal cords | ☐ | ☐ |
| Passes cords | ☐ | ☐ |
| Continues insertion of bronchoscope to level of carina | ☐ | ☐ |
| Passes endotracheal tube atraumatically | ☐ | ☐ |
| Reconfirms vision of carina after ETT in situ | ☐ | ☐ |
| Removes bronchoscope smoothly | ☐ | ☐ |
scoring system (Appendix 2).

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