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REVIEW ARTICLE

BRONCHOSCOPY EDUCATION AND TRAINING

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ABSTRACT

Bronchoscopy is an essential tool in the management of patients with pulmonary diseases. With availability of several new modalities, and a shift from diagnostic to therapeutic bronchoscopy, bronchoscopy education and training are becoming crucial. There is a focus on competence-based training as well as a heightened concern about patient safety. The traditional apprenticeship model is inadequate to address the current needs. There is a wide variation in the training currently offered at the pulmonary training programs, with deficiency in several key modalities like transbronchial needle aspirate. Web-based curriculums and workshops are available and studies show their beneficial impact. Simulation models have revolutionized the education of conventional and endobronchial ultrasound bronchoscopy in the last decade. Several studies have shown that simulators improve and hasten the learning process, and the skills learned on a simulator are transferrable to the real patients. Ongoing studies are investigating a cognitive and skill based assessment tool for credentialing.

BRONCHOSCOPY EDUCATION AND TRAINING

Bronchoscopy is one of the most common procedures performed by chest physicians for the evaluation of various pulmonary diseases including malignancy, interstitial lung disease and infectious and inflammatory disorders. Much has been accomplished since the first rigid bronchoscopy was performed by Gustav Killian in 1897 and the introduction of flexible bronchsocopy by Dr. Ikeda in Japan in the late 1960s. Endobronchial ultrasound (EBUS) was introduced in the last decade and has made a major impact on the accessibility of pulmonary and mediastinal structures, with a potential to replace mediastinoscopy. Newer diagnostic modalities such as navigational bronchoscopy are also making its place in the diagnostic realm. Therapeutic bronchoscopy has witnessed a recent growth with resurgence in rigid bronchoscopy and an availability of a variety of tools such as laser, electrocautery and airways stents. Bronchoscopic treatments are now being offered to patients with asthma and investigated for COPD.

With this ever growing role of bronchoscopy in the management of respiratory patients, bronchoscopy education and training of chest physicians is becoming more important, as well as complex. The trainees are expected to learn not only flexible bronchoscopy, but also EBUS if available at the training institutions. Even the practicing pulmonologists are trying to learn and incorporate EBUS and navigational bronchoscopy in their practice.

There is an increasing recognition of the complexity of adult learning and concerns of patient safety. The Accreditation Council for Graduate medical Education (ACGME) in United States, American Board of Medical Specialties and Association of Medical Education in Europe recommend the use of competence-based metrics to measure the knowledge and skills of trainees. Competence is a habitual and judicious use of knowledge, technical skills and judgment for the benefit of society. The domains of competence include knowledge, patient care, communication, professionalism, system-based practice and practice based learning.[1] Competence based education has been shown to improve trainees' education and patient safety.[2] When applied to bronchoscopy, competency needs to be established not only in the technical skills, but also in the cognitive knowledge and reasoning.

Traditional Apprenticeship Model

The traditional apprenticeship model "see one, do one and teach one" has been the backbone of teaching and training physicians for centuries. The advantages include close mentor-mentee interaction and immediate feedback. However, with the complexity of medical practice, and increased concern over patient safety, the sole use of this method is being questioned. It is unlikely that a trainee would be exposed to the whole spectrum of indications, scenarios and procedural modalities of bronchoscopy. There is also a concern that a novice bronchoscopist spends more time to complete a procedure, with higher chances of incomplete survey, more airway wall contacts leading to increased patient discomfort and higher risks of complication like pneumothorax.[3]

There is a wide variation in the level of training offered at various programs in US. Surveys of pulmonary fellows and program directors show that only 70% of the graduating fellows receive training in transbronchial needle aspirate (TBNA) and bronchoscopic intubation.[4,5] It was also reported that the most common mode of education was the individualized education by the faculty, followed by bronchoscopy lectures, case discussions and text books. Only 59% fellows had some training on the lung models and 33% trainees learnt from other fellows.

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Role Of Bronchoscopy Curriculum

A detailed and comprehensive bronchoscopy curriculum is essential for bronchoscopy training. Cognitive expertise is the foundation of technical expertise. The trainees should be able to understand the indications and contra-indications of bronchoscopy, alternatives of bronchoscopy, pre-procedure clinical assessment of the patients, management of the patients during the procedure including sedation, post-procedure care, and complications. This is in addition to the knowledge of airway anatomy, pulmonary physiology, and knowledge about the bronchoscope and different instruments.

Several textbooks are available which provide an excellent overview of these areas. However, web-based learning has revolutionized the education in the 21st century. One of the on-line bronchoscopy curriculums is Essential Bronchoscopist (www.bronchoscopy.org) which is available free of charge in several different languages.[6] It consists of 6 modules consisting of 186 questions, along with explanations. It is endorsed as a complementary learning instrument by several international bronchoscopy and pulmonary organizations including World Association for Bronchology. Essential Bronchoscopist is utilized in United States and is assessed for training in developing countries.[6,7] The information has been found to be useful, interactive, relevant and easy to remember.

We recommend review of recent American College of Chest Physicians (ACCP) consensus statement to administer sedation and analgesia during bronchoscopy.[8]

ROLE OF SIMULATION

One of the revolutionary developments in the training and education of medicine is the introduction of simulation. The simulators have proven their integral place in the aviation and space travel industry. They have been adopted in anesthesiology and various surgical and medical specialties like gastroenterology already. Two types of simulation systems for bronchoscopy are available. There are low-fidelity inanimate, mechanical airway models and high-fidelity computer-based electronic simulators.

Low –Fidelity Simulator

Low-fidelity models consist of molded airway trees that offer accurate anatomy to the first segmental level. CLA Broncho Boy (CLA, Coburg, Germany) is one example (Figure I). These models help learn basic anatomy, and improve hand-eye co-ordination and muscle memory. They are cheap, and a skilled operator can help guide the trainee. However, the use of these models lacks direct feedback, variety of training scenarios and anatomic variables. In a prospective study, Davoudi and colleagues compared the low and high-fidelity simulators for blind transbronchial needle aspirate (TBNA) training.[9] The learners felt that both the models were equally enjoyable, however, the low-fidelity simulator was more realistic and easy to work with. The instructors also found the low fidelity model more effective for transbronchial needle aspirate training.

High-Fidelity Simulator

High-fidelity simulators consist of a proxy bronchoscope, robotic interface and a personal computer with a monitor (Fig II and III). The proxy bronchoscope is introduced through the nose and navigated through a 3-dimensional reconstruction of the airways on the monitor. The robotic interface tracks the motion of the bronchoscope and reproduces the forces felt during the actual bronchoscopy. The “virtual patient” breathes, coughs and vital signs are displayed. Various standardized scenarios are offered and the learner can choose to examine the normal airway, perform difficult intubation, endobronchial brushings and biopsy and TBNA of a mediastinal lymph node. The simulator can label the airways and surrounding structures for the learner. The software tracks the duration of the procedure, airway collision, doses of lidocaine and effectiveness of brushings, BAL and endobronchial biopsies.

There are two commercially available hi-fidelity systems in the US: The Endoscopy VR simulator (CAE Healthcare, Montreal, Quebec, Canada) and the GI-Bronch Mentor (Simbionix Ltd, Israel).

High-fidelity simulation offers numerous advantages including repetitive practice, training in a safe stress-free environment, exposure to rare or difficult scenarios, and receiving immediate feedback on performance.

Studies have looked at the feasibility and impact of simulation in bronchoscopy training. The first reports of the efficacy of the bronchoscopy high-fidelity simulator were published in 2001. Colt and colleagues reported the outcomes of five novice bronchoscopists who received 4 hours of training on a bronchoscopy simulator and then spent four hours practicing on their own without supervision; bronchoscopy skill sets obtained by the novices (dexterity, speed, and accuracy) reached those of a control group of skilled bronchoscopists (who had performed at least 200 bronchoscopies) after only 8 hours of training.[10] Ost et al. validated the bronchoscopy simulator as an assessment tool and demonstrated its ability to discriminate among bronchoscopists with varying levels of

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bronchoscopy skills; the study found that expert bronchoscopists (>500 bronchoscopies) performed better than intermediates (25-500) who in turn performed better than novices.[11]

More recently, Wahidi and colleagues reported the first prospective multi-center study of performance-based metrics and educational interventions in the learning of bronchoscopy among starting pulmonary fellows.[7] In this study, two successive cohorts of first year pulmonary trainees were enrolled.

At pre-specified milestones, validated tools were used to test their bronchoscopy skill and knowledge: the Bronchoscopy Skills and Tasks Assessment Tool (BSTAT), an objective validated evaluation of bronchoscopy skills with scores ranging from 0-24, and written multiple-choice questions examinations.

The first cohort of fellows received training in bronchoscopy as per the standards set by each institution, while the second cohort received training in simulation bronchoscopy and was provided an on-line bronchoscopy curriculum. There was significant variation among study participants in bronchoscopy skills at their 50th bronchoscopy, the number previously set to achieve competency in bronchoscopy. An educational intervention of incorporating simulation bronchoscopy enhanced the acquisition of bronchoscopy skills, as shown by the statistically significant improvement in mean BSTAT scores for 7 of the 8 milestone bronchoscopies ($p<0.05$). The online-curriculum did not improve the performance on the written tests; however, compliance of the learners with the curriculum was low. The key message of the study was that structured training of bronchoscopy including simulation results in measurable improvement in the bronchoscopy technique when performed on the actual patients.

Role of Bronchoscopy Workshops and Courses

One of the ways to expose novice operators to basic and advanced diagnostic and therapeutic bronchoscopy is through dedicated workshops or courses. These courses typically incorporate didactic lectures, often by renowned experts, followed by practice on simulator or animal models. It is not a surprise that these courses are increasingly popular not only among the trainees in pulmonary fellowship, but also among pulmonologists in practice who are interested in newer bronchoscopy modalities, including EBUS and navigational bronchoscopy.

In one study, 24 first year pulmonary and critical care trainees who attended a one-day introductory bronchoscopy course were tested on knowledge and technical skills before and after the workshop. There was a significant improvement in both aspects after the course.[12]

Current Accreditation of Bronchoscopy Competence

Bronchoscopy competence is currently measured by subjective approval of the program director or mentor, and based on a fixed arbitrary number of bronchoscopies performed by a trainee. ACCP has recommended performance of 100 bronchoscopies in a supervised setting during training and performance of 25 bronchoscopies per year afterwards to maintain competence.[13] Though there is a correlation between the number of surgical procedures and outcomes,[14] there is a wide variation in individuals' dexterity and learning capability. Thus, this accreditation method is considered flawed with the absence of an objective assessment of knowledge and skills.

Future Of Bronchoscopy Competence Testing

There is a shift in academic medicine towards competency-based education, which requires standardized evaluation methods for knowledge and skills. 25-questions set from Essential Bronchoscopist web-based curriculum have been found to provide material for the competency-based test of bronchoscopy knowledge.[15,16] This test has shown satisfactory discriminative ability, validity and reliability, and is being used in studies evaluating the learning curve of physicians in-training.[7]

Several bronchoscopy skills assessment tools have been described.[15,17,18] BSTAT is one of such tools which provides a structured, measurable way of evaluating procedure competency. It has a proven validity and interrater reliability and discriminates between experienced and novice operators.[7, 17] It provides a numeric score based on objective evaluation of the bronchoscopist's skills in areas like posture, hand position, maneuvering of the bronchoscope, identification of correct airway anatomy and survey, description of respiratory secretions and mucosal abnormalities and performance of various bronchoscopic tasks.

We recommend standard utilization of such tools for assessment of knowledge and skills and to provide objective feedback to the trainee.

Training in Endobronchial Ultrasound Bronchoscopy (EBUS)

As the role of linear EBUS is becoming more important in sampling of benign and malignant mediastinal lesions, and radial EBUS in biopsy of pulmonary nodules, there is more interest in adequate training of fellows as well as practicing pulmonologists. There are good textbooks, atlas and web-based curriculums available. However, the data regarding the training and learning curve of EBUS is still sparse.

One study evaluated two pulmonologists who had experience with flexible bronchoscopy and radial EBUS. The learning curve of linear EBUS improved rapidly up to 20 procedures and continued to improve beyond 50 procedures.[19] Beyond routine bronchoscopy knowledge and skills, EBUS requires knowledge of mediastinal anatomy, skills of driving a bronchoscope with reduced optics and an oblique angle of view, interpretation of the ultrasound images and dealing with a different needle for aspiration.[20] A high-fidelity simulator is available in US (Immersion Inc, San Jose, California, USA) which can be very useful in learning mediastinal anatomy and practicing with an EBUS scope. A Canadian study evaluated such a simulator (AccuTouch Flexible Bronchoscopy Simulator, CAE Heathcare, Montreal, QC, Canada) in novice operators and found that the simulator led to more rapid acquisition of the skills and the percentage of lymph nodes successfully identified.[21] The same group of authors also showed that there was no difference in procedure time or number of successful aspirates between two groups of trainees: group 1 trained on simulator vs group 2 trained on 15-25 patients. The only difference between the two groups was that the simulator trained group took longer to intubate the patients with the EBUS scope.[22] Hence, the skills learnt on the simulator are readily transferred to the real patients. A low-fidelity model (Olympus Inc., Center Valley, Pennsylvania, USA) consisting of tubular airways with surrounding silicone balls mimicking various lymph node stations is available as well.

ACCP recommends 50 EBUS guided TBNA for initial competency, and 20 procedures a year to maintain competency.[13] For pulmonary fellowship programs, EBUS training will soon be a part of the curriculum. An optimal program will provide a high or low-fidelity simulator practice followed by training on the patients under close expert supervision. Pulmonologists in practice will have to rely on EBUS curriculums and courses with simulation or animal models and possibly proctoring from local experts like esophageal ultrasound trained gastroenterologists.

RIGID BRONCHOSCOPY TRAINING

Rigid bronchoscopy is becoming more popular in last two decades as a therapeutic modality for malignant and non-malignant airway disorders, as it allows control of the airway and deployment of various types of stents and use of ablative modalities like laser. In US, rigid bronchoscopy is generally offered at the centers of excellence and one year interventional pulmonary fellowship is necessary for optimal training.[23] ACCP recommends 20 rigid bronchoscopies for initial competency and then 10 procedures a year to maintain it.[13]

CONCLUSIONS

Bronchoscopy education is an essential component of a pulmonary training program. We recommend incorporation of close expert supervision and guidance, along with a comprehensive curriculum and a high or low-fidelity simulation model. Regional or international courses may offer additional learning opportunities. A competence-based evaluation and credentialing system to assess both the knowledge and skills is essential to a successful training program.

Conflict of Interest:

K Mahmood has no conflict of interest.
MM Wahidi has no conflict of interest.

Figure I: Low-fidelity simulator

Figure II: High-fidelity simulator

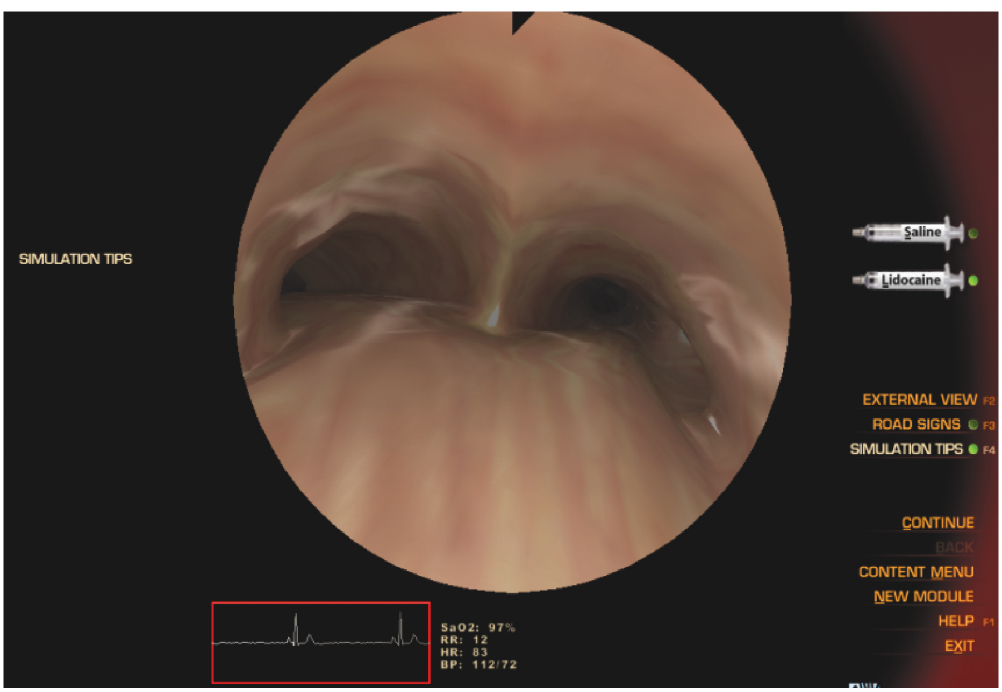

Figure III: High-fidelity simulator monitor

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