10 Bronchoscopy Education

Henri G. Colt

Experience is the name everyone gives to their mistakes.

– Oscar Wilde
(From Ladywindemere's Fan, Act III, 1892)

Background

John Dewey (born 1859–1952), probably one of America's most influential philosophers, wrote "the belief that all genuine education comes about through experience does not mean that all experiences are genuinely or equally educative." While this well-known psychologist, social critic, and political activist was commenting on the practices of 1930s traditional versus progressive education in America's schools, his words still ring incredibly true today when applied to medical education and, more specifically, to procedure-related learning.

Surveys pertaining to flexible bronchoscopy conducted in countries as diverse as Singapore, Great Britain, India, Poland, Egypt, and the United States have consistently identified variations in practice and training. The diversity of the educational process is the consequence of a lack of uniform requirements, paucity of structured curricula, absence of validated measures of competency and proficiency, unequal access to learning materials, variability of patient-based learning experiences, and differences in skill, interest, and teaching abilities of medical practitioners designated to be bronchoscopy instructors. Furthermore, the lack of a uniform competency-based framework for bronchoscopy education brings into question the rigor and effectiveness of many postgraduate programs that target physicians who wish to acquire new skills and procedures that can be introduced into their practices.

Traditionally, graduate medical education has been based on the Halstedt educational model of see one, do one, teach one implemented during a medical apprenticeship. This model which, until recently, has been employed on an almost universal and all but uncontested basis, was designed to replace the unstructured servitude in place until 100 years ago. It is based on the constraints of training for a fixed period of time, assimilation of material presented through more formal teachings, actual experience with patients, escalating responsibilities, and a period of supervised practice after training.

Bronchoscopy has been part of subspecialty training (for pulmonologists, intensivists, some surgeons, and anesthesiologists). Uniform, structured content is lacking, however. In addition, objective assessment tools have not been sufficiently explored. Training experiences and responsibilities are highly variable, and, at least in the United States, training program directors declare their trainee's competency and professionalism based on completion of their years of subspecialty training and a declaration of overall number of procedures performed (a number arrived at arbitrarily and based on the opinions of specialists but without actually measuring either technical skills or cognitive bronchoscopy-related knowledge). Furthermore, in the United States, while medical board examinations may contain a very sparse number of fact-based test questions, no assessment methodologies are used to ascertain procedure-related technical, experiential, or affective knowledge. Like other interventional procedures in medicine, physicians and surgeons, therefore, continue to work long hours, increasing their technical skill and experience one patient at a time.

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To enhance this experience, observerships might be sought at institutions around the world, providing practitioners with opportunities to seek the advice and technical expertise of procedure-savvy colleagues who might familiarize them with new procedures. This type of cultural interchange still exists today, not only enriching the knowledge and experience of health-care providers worldwide but also potentially placing physicians and patients into uncomfortable situations whereby patients are asked, if not inexplicitly told, that they must bear the burden of procedure-related training. During one's subspecialty training, patients might also be the unknowing victims of a physician climbing the learning curve of procedure-related skill and knowledge acquisition.

For health-care providers, being obliged to perform what might be for the first time, albeit with guidance, a procedure in a patient is both discomforting and anxiety-provoking (for both patient and physician). In addition, such a learning environment creates a difficult situation for a competent instructor, who knows that he or she can perform the procedure more quickly, more efficiently, and with greater patient comfort than the learner and yet intentionally refrains from interfering so that the physician-in-training might learn. The ethical dilemmas that ensue from such practices cannot be denied.

Of course, additional cognitive knowledge and familiarization with procedural techniques can also be gained from attendance at didactic lectures and workshops, as well as from hands-on training, which might take place during participation in postgraduate courses. At most postgraduate programs, course faculty present didactic lectures and direct group workshops, often consisting of 5–15 trainees per workstation, where they assist and instruct students in the actual procedure on inanimate and animal models. Until very recently, instruction would occur without a formal curricular structure that specifically emphasizes the informative, technical, affective, and experiential elements of knowledge, but in compliance with many continued medical education guidelines, specific objectives for didactic and hands-on session are identified, and course participants are asked to complete a critical review form in which they can point out the particular strengths and weaknesses of the program.

Organizing these programs is hard work, costly, and time-consuming, so it is not surprising that little attention has been paid to researching a program's efficacy, assessing the quality of teaching or the quantity and quality of knowledge and skills transfer and retention. In fact, it is usually assumed that knowledge and skill are acquired by course participants simply because they attended the program and only recently has there been an attempt to explore the use of competency-based metrics in interventional pulmonology-related postgraduate programs.

Changes in the perception of the educational process have been recently catalyzed by modifications of medical educational systems. In the United States, for example, The Accreditation Council of Graduate Medical Education has advocated a competency-based training model, replacing a model based on process and number of cases performed. Advances in, and an increasing acceptance of simulation technology have resulted in the expanded use of both lo- and hi-fidelity simulation, increasingly warranting that neither live animals nor live patients bear the burden of procedure-related training. In bronchoscopy, in fact, several computer-based simulation and inanimate models have been described and validated in specific settings. More widespread use of these and other models, in addition to affordable computer-based simulation, in this author's opinion, will result in greater concerted efforts to uniformize the global bronchoscopy educational process.

In the following paragraphs, I shall review some educational philosophies and methodologies. I shall then review some of the bronchoscopy education-related literature focusing on the use of simulation and competency-based metrics. Finally, in the last section of this chapter, I shall briefly illustrate the content of the recently released Bronchoscopy Education Project, reflect on how social media and web-based materials can be used by learners to expand their scope of practice, and describe several educational strategies and techniques that might be considered to enhance bronchoscopy education.

Philosophies and Methodologies

Procedure-related education, in my opinion, is more about learning than about teaching. While many parallels exist, learning a medical procedure is not the same as learning to play tennis, unless one is becoming a professional athlete. And just as we are not expected to immediately become champion tennis players invited onto the court at Wimbledon, we cannot be expected to become competent bronchoscopists simply by taking the scope in hand and moving to the patient's bedside. Using again the tennis analogy, learning requires acquisition of technical skill, facts (cognition), experience, and an understanding about how we actually feel about what we are doing (affect). The effectiveness of the learning process depends on elements of interaction between the learner and the learning environment; the frequency, variety, quality, and intensity of the learning encounter; the presence, quality, interest, skill, and demeanor of the teacher; the natural talents, genetics, and personality characteristics of the learner; the various means that are used to present learning materials (visual, auditory, multimedia, static, combined); and motivation (peer pressure, personal and third-party expectations, presence or absence of rewards, retribution, or consequences).

But similar to practicing a sport, learning can and should be fun. In this sense, the art of doctoring is learned, in part, because doctors enjoy being doctors, caring for patients, and, when it comes to procedures, doing those procedures well. Thus, learning has intrinsic value. Learning to perform a medical procedure (meaning any type of minimally invasive or open surgical procedure whether performed by medical doctors or surgeons) is different, however, from a sport performed as a hobby, because a certain level of competence is expected, not only of ourselves but also by our colleagues, our patients, and society as a whole. In medicine, the road to mastery is not, as George Leonard says, "goalless." Rather, one must pursue a certain level of skill and knowledge that helps assure a level of competency that ensures patient safety, and our ability to efficiently and effectively reach a diagnosis or generally acceptable and expected therapeutic outcome.

- *Knowledge* generally applies to the body of information required by a physician in order to make a medical decision. In this regard, medical cognition refers to studies of cognitive processes such as perception, comprehension, decision-making, and problem-solving. Medical reasoning, on the other hand, applies to skills that enable a clinical decision. Regardless of whether a physician's training has been practice or science-based, the manner in which physicians reason is a direct consequence of the manner in which they have been educated.
- *Evaluation and assessment* apply to how we discover what and how much the learners are learning and how well they are progressing in their acquisition of knowledge and skills. *Low-stakes* testing usually does not have pass-fail thresholds, or carry significant consequences. In bronchoscopy training, for example, a validated *low-stakes* bronchoscopy skills and tasks assessment tool could be used to help trainees and faculty identify areas in which technical skill can be improved, while scores on a *low-stakes* written assessment could help trainees evaluate their progress in acquiring procedure-related knowledge and provide opportunities for instructors to provide constructive feedback. Such a program would be consistent with an educational process that emphasizes a quest toward professionalism and competency. A *high-stakes* assessment, on the other hand, usually carries significant consequences, such as licensure. High-stakes examinations are used to declare that a person has, for example, met the necessary qualifications to practice medicine. These are usually graded, have a pass or fail component, and are often mandatory in addition to other prerequisites such as number of years of training, or, in an apprenticeship model of instruction, number and quality of procedures performed. Assessments can also be used to ascertain curricular effectiveness, usually with the intent to modify and improve curricular structure and content based on the findings. For all such evaluation studies, significant problems and inaccuracies can arise depending on which outcome measures are used. These measures must be sensitive to the curriculum's stated goals and objectives, or to systemic factors such as outcomes that document a learner's progress through a system (within an institution or region for example).
- *Competency* is the ability gained from knowledge and skills, which form a basis for performance. To be competent means being able to activate and utilize that knowledge, when faced with a problem.
- *Competency-based education* warrants that each competency be teachable, learnable, and measurable. For example, it may or may not be expected that participants in a hands-on and didactic 1-day bronchoscopy program actually improve their knowledge and technical and decision-making skills significantly. On the other hand, it may be expected that participants in a pulmonary and critical care medicine fellowship program acquire competency in performing diagnostic flexible bronchoscopy independently. Agreement is lacking, however, in regard to core competencies versus the acquisition of optional skills. For example, what might be considered optional because of lack of resources or training opportunities in some countries (e.g., a procedure such as endobronchial ultrasound-guided needle aspiration) could be mandatory in others.
- *Certification* is defined as a process that provides assurance to the public that a medical specialist has successfully completed an educational program and undergone some type of evaluation, which almost always includes a high-stakes written examination that is designed to test the knowledge, experience, and skills requisite to the provision of high-quality care in that specialty (accreditation council for graduate medical education). In this setting, *competencies* are defined as the specific knowledge, skills, behaviors, attitudes, and appropriate educational experiences required of trainees to complete graduate medical education programs.
- *Learning curve* was originally used to describe the rate of increase in the productivity of airplane manufacturing workers, who, while performing constantly the same procedure, typically become more efficient. In medicine, a learning curve, which might also be called an *experience curve*, applies to a process where performance improves as a function of practice. This curve may be more or less steep depending on the learner's skill, circumstances, experience, and on whether the procedure being learned is new or established.[1] We increasingly tend to differentiate

[1] German psychologist Hermann Ebbinghaus (1850–1909) is credited with originally describing the learning curve in his work on memory (see RH Wozniak. Introduction to Memory. Classics in psychology 1855–1914: Historical essays. Bristol UK, Thoemmes Press, 1999). Learning curves can be mathematically calculated and may have different shapes representing incremental change, including a series of plateaus, rises and dips, and the traditional ogive "S"-shaped curve.

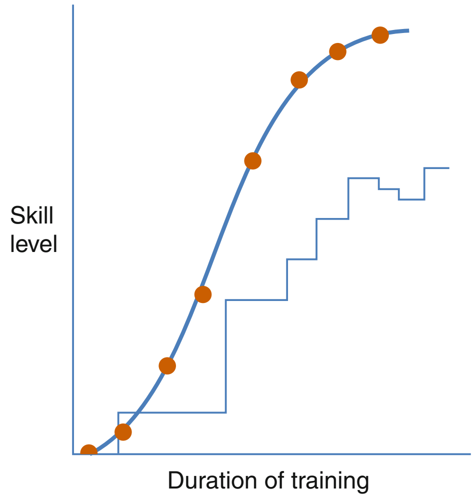

Fig. 10.1 Examples of ogive "S"-shaped learning curve and plateau with incremental gain and occasional dip (Courtesy of Dr. Henri G. Colt, MD)

learners into novices, beginners, intermediate learners, experienced, and experts, but categories such as beginner, intermediate, and competent can also be used. Learning curves are not always curves. Usually, progress is in spurts, or steps, with learners remaining or choosing to remain on a plateau that itself may have its occasional dips and peaks (Fig. 10.1). Diligent practice, time, and a focused quest for improvement will eventually result in a move to a higher plateau, only to be rapidly followed by a swift, and hopefully temporary, decline to another plateau, which, in many cases, can still be higher than the preceding ones. It is a fact that an expert in one technique may be a novice in another. Of course, it is possible that the expert will climb the learning curve more quickly than one who has no prior experience, but this can depend on one's area of expertise. For example, a young man with years of experience playing video games, may quickly become very good at two-dimensional video bronchoscopy, compared with an experienced surgeon who has worked constantly in a multidimensional open surgical world. This raises the issue that learning also depends on what has already been learned,[2] a paradox clearly identified by Plato in the dialogue *Meno*, when Socrates says

> I know, Meno, what you mean…you argue that a man cannot inquire either about that which he knows, or about that which he does not know; for if he knows, he has no need to inquire; and if not, he cannot; for he does not know the very subject about which he is to inquire.

[2] This is illustrated by David Ausubel (1918–2008) in his meaningful reception theory where, contrary to rote memorization or discovery learning based on problem-solving, one's knowledge of new material is enhanced if the material is related to relevant ideas within the learner's existing cognitive structure (http://tip.psychology.org/ausubel.html, downloaded December 27, 2010).

Bronchoscopy-Related Education Literature

The bronchoscopy-related literature is gradually supporting the paradigm shift whereby patients will no longer bear the burden of procedure-related training. In a review of 10 papers pertaining to the use of simulation for bronchoscopy education, we noted that simulation was demonstrated to help learners improve procedural efficiency and economy of movement, thoroughness, and accuracy of airway examination and decrease airway wall trauma. In addition to increasing learner satisfaction and interest, simulated environments create opportunities where tasks can be practiced repeatedly, risks to patients are eliminated, and training scenarios can be tailored to individual learners' needs. Both lo- and hi-fidelity simulation have been shown to enhance physician competency in procedural skills while saving time and improving the learning curve. While not yet shown conclusively in bronchoscopy, procedural skills acquired through practice on simulators are transferable to the clinical setting. In addition, simulator training with objective assessment and feedback identifies errors and provides opportunities for repeated and focused practice without exposing patients to unnecessarily prolonged procedures and discomfort.

Hi-fidelity simulation platforms using three-dimensional virtual anatomy and force-feedback technology can be used, for example, to teach conventional transbronchial needle aspiration (TBNA), although less expensive, lo-fidelity models comprised of molded silicone or excised animal airways are also effective. We demonstrated the efficacy of a lo-fidelity hybrid airway model made of a porcine trachea and a plastic upper airway for learning transcarinal and transbronchial needle aspiration. This model gave learners an opportunity to practice needle insertion, positioning, safety measures, and communication with ancillary personnel. This model has since been modified so that a plastic airway is used, obviating the need for discarded animal parts and making the use of such training materials possible in hotel conference centers and nonhospital facilities. Models can be used to teach scope manipulation and airway anatomy, foreign-body removal, bronchoscopic intubation, endobronchial ultrasound-guided TBNA, and various other interventional techniques (Fig. 10.2). In fact, based on learner and instructor perceptions, a lo-fidelity model was shown to be superior to costly hi-fidelity computer simulation for learning three different conventional TBNA techniques.

Demonstrating improvements in technical skill complete only part of the picture. The increasing emphasis on competency-oriented education also warrants that bronchoscopy courses use competency-based measures to assess the efficacy of course curricula and training

Fig. 10.2 Examples of hi-fidelity and lo-fidelity models for teaching bronchoscopic inspection, conventional transbronchial needle aspiration, and endobronchial ultrasound (Courtesy of Dr. Henri G. Colt, M.D.)

modalities. Outcome measures might take the form of high- or low-stakes testing in the various cognitive, technical, affective, and experiential elements of procedure-related knowledge. Using quasiexperimental study design and a series of pretest/posttest assessments with calculations of absolute, relative, and class-average normalized gain, we have demonstrated the efficacy of a 1-day structured curriculum including didactic lectures, workshops, and hands-on simulation-based training. Studies are ongoing to determine how various elements of knowledge can be assessed using components of the Bronchoscopy Education Project described later in this chapter[3] (Figs. 10.3, 10.4, and 10.5).

[3] Cognitive knowledge could be assessed using standardized testing with written multiple-choice questions and oral interviews. Test questions should ideally be validated using specific criteria that include testing for difficulty and internal reliability. Technical skill assessments can be used to document progress along the learning curve, using measures that are validated and reproducible and have a strong correlation to the procedure being taught. Various Bronchoscopy Assessment Tools© can be used to document improvement in dexterity, accuracy, speed, position and posture, economy of movement, atraumatic instrument manipulation, anatomic recognition, and navigation. Checklists can be used to ascertain competency in various components of a procedure such as ability to obtain informed consent or safe use of fluoroscopy. Experiential and affective knowledge can be explored using graded patient-centered learning exercises and structured simulated clinical scenarios.

Description of a Transnational Education Initiative

The Bronchoscopy Education Project[4] entails the design, development, and dissemination of a series of structured, uniform curricula that include required reading assignments, simulation scenarios, standardized didactic lecture material, validated assessment tools, and checklists (Fig. 10.3). The purpose of this project, officially endorsed by several international bronchology and interventional pulmonology societies, is to provide bronchoscopy educators and training program directors with competency-oriented tools and materials with which to help train bronchoscopists and assess progress along the learning curve from novice to competent practitioner. Material can be incorporated in whole or in part, as needed by each program. Learning is based on the review of written materials, focused practice during hands-on programs and during the course of subspecialty training, and through easy access to educational materials as available at specifically designed websites, YouTube, and Facebook.

In addition to many written materials and structured didactic lectures provided through regional on-site programs, a free, web-based six-part curriculum is being developed with the assistance of numerous experts from around the globe.

[4] For more information, search Bronchoscopy International on YouTube and Facebook, or go to www.Bronchoscopy.org.

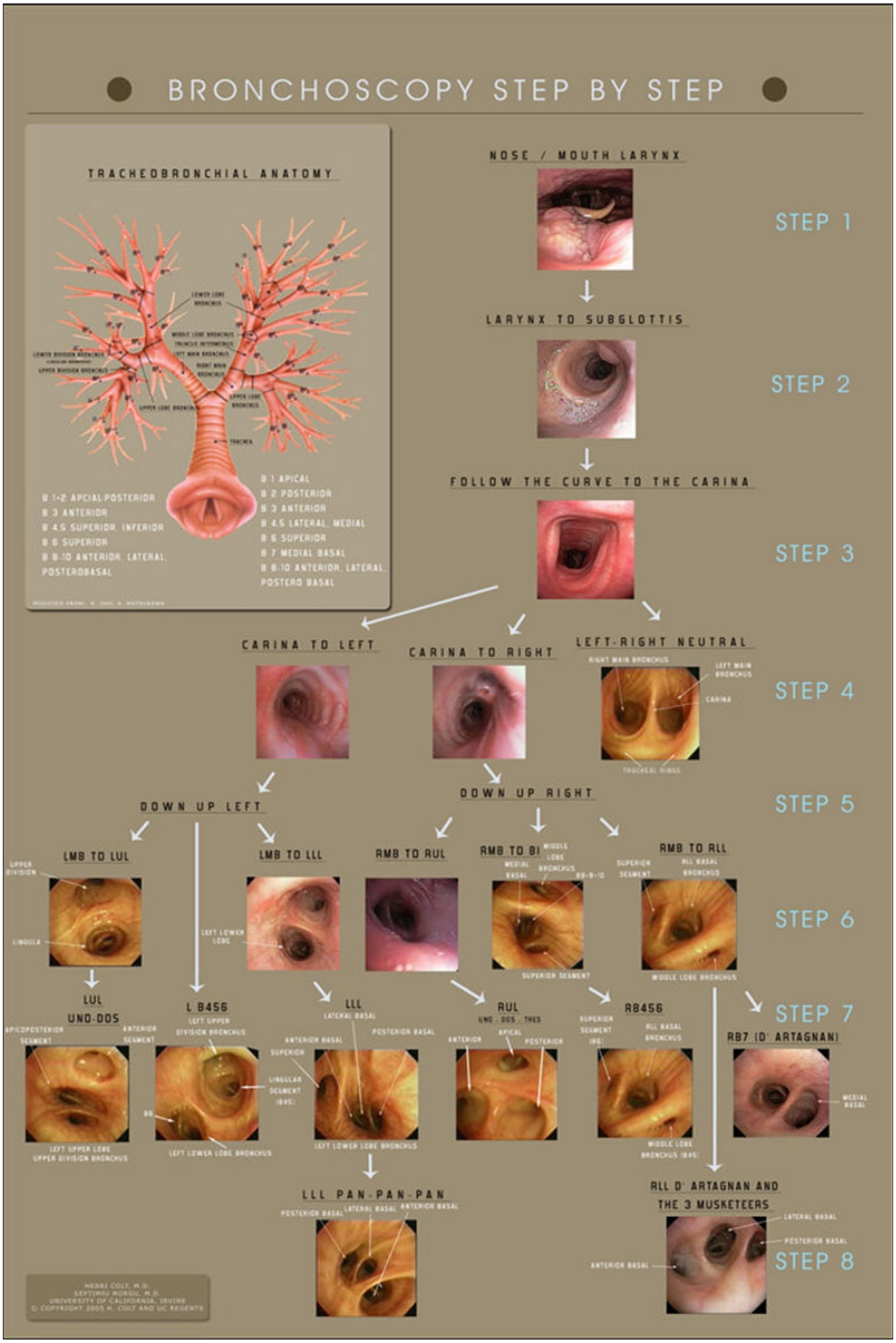

Fig. 10.3 Example of Bronchoscopy step-by-step instruction. Colt HG. *Bronchoscopy Lessons.* Instructional video pertaining to various aspects of bronchoscopy You Tube (posted 2010): http://www.youtube.com/watch?v=phRv73Ik7fI&feature=related (Courtesy of Dr. Henri G. Colt, M.D.)

Fig. 10.4 Example of checklist used as part of The Bronchoscopy Education Project. See Colt HG. *Bronchoscopy Education Project Rationale*. Instructional video You Tube, posted July 2010: http://www.youtube.com/watch?v=ogRixvyTYEA (Courtesy of Dr. Henri G. Colt, M.D.)

FLUOROSCOPY 10-Point CHECKLIST*

Student ______________________________ Training Year __________

Faculty ______________________________ Date __________________

☐ Interactive session ☐ Patient environment

Educational Item* Items 1−10 are scored 10 points each (no partial points given)	**Satisfactory Yes/No**
1. Able to list indications for using fluoroscopy	Yes / No
2. Able to describe the relevance of voltage and amperage ☐ For image quality ☐ For patient safety	Yes / No
3. Able to describe consequences of resolution, distortion, and lag ☐ For image quality ☐ For patient safety	Yes / No
4. Able to describe consequences of brightness and contrast ☐ For image quality ☐ For patient safety	Yes / No
5. Able to describe dangers of scattered radiation	Yes / No
6. Able to describe techniques to improve visibility of fluoroscopic image	Yes / No
7. Able to describe techniques used to reduce patient radiation exposure	Yes / No
8. Able to describe techniques used to reduce operator radiation exposure	Yes / No
9. Able to describe special precautions in case of suspected or known pregnancy ☐ Patients ☐ Health care providers	Yes / No
10. Able to describe basic operation procedures	Yes / No

* Each of the 10 items contains all of the elements required by ACGME(patient care, medical knowledge, practice-based learning and improvement, interpersonal communication skills, professionalism, and systems-based practice).

FINAL GRADE PASS FAIL **SCORE** ______/100

Procedures are deconstructed into three elements: strategy and planning, technical skills, and outcomes assessment (results, quality control, ability to respond to complications, and long-term management). In order to identify elements crucial to medical reasoning when entertaining a bronchoscopy consultation, these elements are further divided into four categories using a four-box *Practical approach to procedural decision making*: patient evaluation, procedural strategies, techniques, and outcomes. A series of practical approach exercises is one of the six elements of the web-based curriculum. Other elements are:

The web-based *Essential Bronchoscopist*© and *EBUS Bronchoscopist*© comprised of specific reading materials, learning objectives, and post tests. Each module contains numerous question-answer sets with information pertaining to the major topics relating to bronchoscopic procedures (anatomy and airway abnormalities, patient preparation, indications, contraindications and complications, techniques and solutions to technical problems, disease states, imaging, procedural techniques, anesthesia and medications, equipment and its maintenance, as well as history and education). The aim of these modules is not to replace but to complement the subspecialty bronchoscopy training environment and motivate learners to ask questions of their preceptors and colleagues.

A *Bronchoscopy Step-by-Step*© and *EBUS Step-by-Step*© series of graded exercises help learners acquire the technical skills necessary for basic diagnostic bronchoscopy. Instructional videos are readily viewable on desktop computers as well as handheld devices, IPADs, or cell phones. Specific training maneuvers help the learner practice incrementally difficult steps of bronchoscopy and EBUS-TBNA. Steps are designed to enhance the development of "muscle memory" by breaking down complex moves into constituent elements and practicing the separate elements repeatedly before gradually combining them into more complex maneuvers.

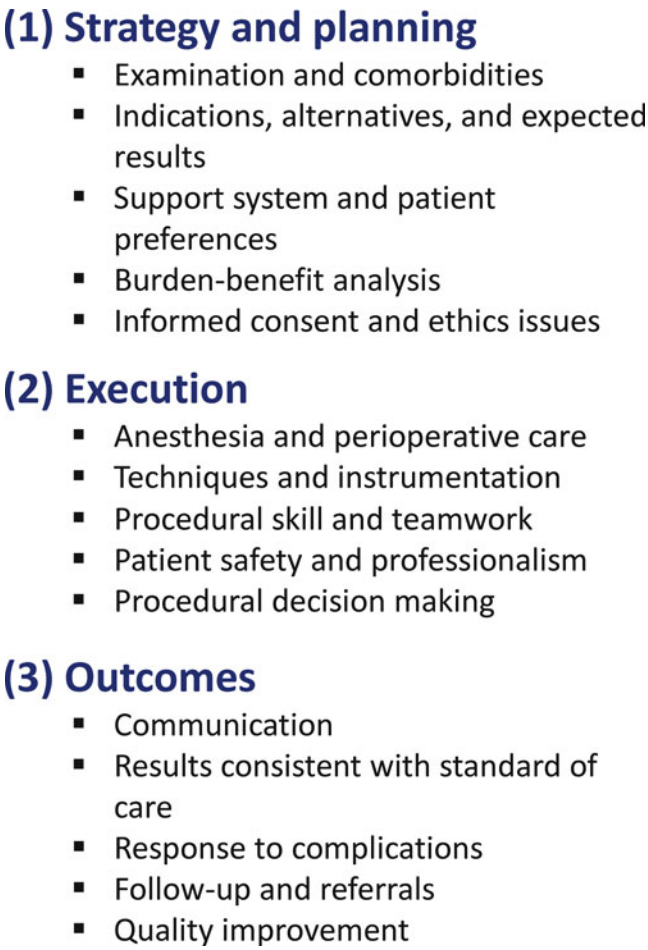

Fig. 10.5 Deconstruction of a bronchoscopic procedure to enhance patient-centered learning and educational interventions within the learner's zone of proximal development (Courtesy of Dr. Henri G. Colt, M.D.)

A series of *Bronchoscopy Assessment Tools*© provide objective measures with demonstrated validity and interobserver reliability. Fixed numeric and grade scores can be attributed to the learner based on technical skills that include dexterity, accuracy, anatomic recognition and navigation, posture and position, economy of movement, and atraumatic instrument manipulation, pattern recognition, and image analysis.

Two additional elements are *The Art of Bronchoscopy*© and *BronchAtlas*© series of PowerPoint presentations pertaining to airway pathology, normal airway examination, and techniques of basic diagnostic and therapeutic bronchoscopic procedures. The goal is to provide free access to edited images and scientific content so that bronchoscopists might freely use materials for their own education and also to facilitate their efforts while preparing lectures within their own institutions and national societies, thereby increasing awareness of both the art and science of bronchoscopy in their communities.

Learner-Teacher Interactions Define Bronchoscopy Education

The experiential learning necessary to become a competent bronchoscopist includes passive experiences (something that happens to or is delivered onto the learner) and interactive processes (something in which the learner is actively engaged mentally, physically, and emotionally). Dewey called this learner-focused activity "learning by doing," also suggesting that thinking is stimulated by problems the learner is interested in solving. For medical practitioners dedicated to the health and well-being of their patients, learning in this way obviously creates intrinsic value and serves to enhance the learning process.[5]

As our understanding of what we are doing increases and as we move toward becoming one with the activity at hand, we can become increasingly aware of the intrinsic value of that activity in our lives. Wolfgang Kohler, a German Gestalt psychologist (1887–1967) noted that such insight, defined as a way for "seeing" the link between certain ideas, is crucial to the learning process because learning is more than the simple reinforcement of our operant behaviors.

For unspecified reasons, physicians are expected to be good mentors and effective instructors without ever having learned to teach. Such an approach to the learning process runs contrary to practice in other fields (such as public school education, hobbies, or sports) and represents a significant shortcoming of our academic institutions and profession. As knowledge becomes more universally available, the attitudes and behaviors of health-care providers will change accordingly not only toward patients but also toward the next generation of medical practitioners. Learners are already less dependent on rote memorization, referring frequently to web-based instruction, electronic information delivery systems, and social media available through their computers or handheld devices. Educators will need to become more

[5] The constructivist psychologist Lev Vygotsky (1896–1934) believed that learning and development depend on social interaction. Focusing primarily on how children learn, he described a zone of proximal development (ZPD) as "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (L.S. Vygotsky: *Mind in Society: Development of Higher Psychological Processes*, p. 86, John-Steiner, Cole, Scribner, and Souberman Editors, Harvard University Press ,1980). Tinsley and Lebak expanded on this theory, describing a zone of reflective capacity in which adults increased their ability for critical reflection through feedback, analyses, and evaluation of one another's work in a collaborative working environment (Lebak, K. & Tinsley, R. Can inquiry and reflection be contagious? Science teachers, students, and action research. Journal of Science Teacher Education;2010: 21;953–970).

proficient at the delivery of educational materials and focus on global measures of competency and professionalism that reflect more than might simple grade scores on a multiple-choice examination. An emerging interest in new leadership development programs, specifically designed train-the-trainer seminars, and well-planned teaching scenarios that allow bronchoscopy educators to become familiar with and experiment with various educational approaches, therefore, will likely improve the educational process for physicians-in-training as well as for experienced bronchoscopists desiring to master a new procedure.

Dewey compared a *traditional* educational approach, whereby learners are meant to master educational content delivered from a teacher-knows-best perspective, often using conventional methods of instruction, to a *progressive* approach, whereby teachers try to focus attentions on the explicit needs and interests of their students. Fenstermacher and Soltis describe a third, *humanistic* approach, whereby teachers strive to impart knowledge within an environment in which learning has personal meaning for the learner, helping the learner gain his or her own knowledge and skill.

Regardless of the approach, several teaching techniques described in general education can be employed in medical procedure-based instruction. In the *facilitator* technique, for example, the instructor assumes that the learner has already acquired certain knowledge. In bronchoscopy, this might be achieved by insisting and perhaps verifying that learners view instructional videos and complete mandatory reading assignments prior to an on-site educational intervention. The instructor guides, nurtures, and encourages student-driven learning through constant and for the most part, positive feedback. During hands-on instruction, an instructor could avoid handling the bronchoscope (a true hands-off technique for the teacher), letting instead the learners maintain control as they are individually coached through the resolution of skill-based problems (a truly hands-on technique for the learner).

In other instances, an *executive* technique might be used; its efficacy often measured by how much knowledge is actually gained by the learner. This strategy includes the planning, execution, and assessment of a variety of educational interventions. Opportunities are created whereby the learner has a chance to actually learn what is being taught. For example, a curriculum might be intentionally constructed to assure repetition and reinforcement, checklists might be used to assure that each step of a particular technique is mastered before moving on to the subsequent step, and active engagement time, defined as the amount of time actually spent learning by the learner, could be maximized. Returning to the example of a hands-on workshop, learners could be exposed as a group to baseline instructions, demonstrations, and learning objectives using web-based materials prior to coming to an individual workstation. This would allow station instructors to devote all of their time to teaching specific aspects of the task at hand, avoiding small talk, unhelpful anecdotes, or storytelling. Checklists could be completed to document skill acquisition (Fig. 10.4). It is noteworthy that a workshop that allows 50 min for five learners, in the best of cases, provides only 10 min of actively engaged time per learner undergoing one-on-one individual instruction. One wonders how much is actually being learned by the majority of workstation participants during the other 40 min.

While Ferstermacher and Soltis's facilitator approach values how the learner feels as a person, the executive strategy emphasizes the acquisition of knowledge as an end in itself. A third, *liberationist* approach dares to challenge the learner to create, imagine, and wonder in an attempt to understand and gain knowledge of the task at hand. Rather than demonstrate, for example, how a specific technique is performed, the instructor might ask the learner to discover his or her own way of demonstrating the skill comfortably and without traumatizing the airway or jeopardizing the equipment. Rather than giving strict instructions of procedural technique based on "this is how we have always done it," the instructor might instead share general principles with the learner, such as "think of what you are going to do rather than just doing it," "think of and demonstrate various ways this could be done atraumatically rather than just doing it," and "perform the procedure with ease and greatest economy of movement."

Conclusion

It is a paradox that a profession that constitutes caring for other human beings is essentially learnt by forcing many patients to bear the burden of procedure-related training. As the use of alternative learning methodologies such as practicing on models, computer-based simulation, small group patient-centered discussions, and fingertip availability of media-based instruction are explored and their efficacy demonstrated, learning bronchoscopy through trial and error purely at the patient's bedside will become increasingly unjustifiable normatively. By this, I mean in the sense that learning *on the job* will no longer represent what ideally *should* or *ought* to be done.

The paradigm shift in bronchoscopy education is therefore unavoidable. Overall scope of practice will also be enhanced, as bronchoscopists become increasingly familiar with the language and tools of the education process: train the trainer programs will become necessary to assist potential educators in their efforts to effectively deliver program content and build competency-oriented programs within their own institutions and regions. Uniformization of educational content and process will facilitate social interactions, knowledge transfer, and equality of care in a global community. Bronchoscopy educators will learn how to alternate between various instructional techniques dependent on the learning context and educational strategy employed. Hopefully, our medical societies, subspecialty organizations, and universities will look favorably[6] on those motivated individuals willing to commit time, energy, and a major component of their academic careers to the training of a new generation of bronchoscopists who will learn without putting their patients in peril.

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[6]By this, I imply financial support and recognition through faculty development programs and academic promotions and through a willingness to publish education-related research and commentaries.

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