EDITORIAL

BRONCHOSCOPY TRAINING IN THE 21ST CENTURY

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The purpose of this essay is to briefly outline the immense changes that are taking place in the realm of medical education and explore their relevance to bronchoscopy and interventional pulmonary medicine. The most prominent of these developments include competency-based outcome-oriented training, e-learning and web-based instruction, and the increasing use of simulation in medical education. Together, these models are changing the face of medical education at an incredible pace.

The primacy of patient safety and the accountability of healthcare professionals to the public distinguish the practice of medicine today from what was considered the norm only one generation ago. Society increasingly demands to be reassured that physicians are knowledgeable and competent in their scope of practice. This has led medical educators to propose new curricula based on a "competency-based" paradigm.[1] These curricula differ from the traditional models in that they do not focus on the process and system of education, such as what was taught and how, but rather on the ultimate outcomes, which are the knowledge and competencies acquired. Competency is defined as the ability gained from knowledge and skills, which is the basis for performance.[2] Extensive research on competency-based education has demonstrated that it has the ability to improve medical trainee performance and enhance patient safety and comfort; this is especially true when training in invasive procedural skills.[3]

Because assessment methods and tools are needed to measure the effectiveness of instructional programs, competency-based assessment methods have been developed alongside these curricula to evaluate the utility and efficiency of this new learning paradigm. This movement has not been limited to western industrialized countries; leading educators in nations across the globe,[4] from China to Iraq, and from Brazil to the Sudan have embarked on competency-based projects.[5,6]

An equally radical movement in medical education is the exponential growth of web-based learning, along with other e-learning media.[7] This trend has been well underway for several decades in sciences and engineering. In medicine, certain areas such as evidence-based medicine and public health have been frontrunners for many years. The internet is thriving with searchable dictionaries and compendia of information pertinent to a variety of medical topics, including

patient education. In radiology, for example, a large number of websites have been dedicated to interactive e-learning and image-sharing. Likewise, in the teaching of basic sciences to undergraduate medical students, resources have been allocated to education in anatomy, physiology, biostatistics and physical examination skills.

In the industrial world, the internet is now established as the primary method of accessing medical literature. Regrettably, many medical websites, journals, and texts are still not freely accessible. Initiatives to make this material available to physicians practicing in developing countries are invaluable, because they allow the developing world to become an equal participant in the global discourse on health. One of the best examples of one such initiative is the BMJ Publishing Group's move to allow free access to electronic versions of its 23 specialist journals to anyone in more than one hundred third world nations.[8]

Alongside this trend is the awe-inspiring work that has been done in the field of simulation technology. The aviation industry and other technical fields such as industrial engineering and architecture use simulation to minimize harm and cost while increasing efficiency for many years. In the past decade simulation has also found countless applications in medicine and surgery. Today, the use of simulation for surgical education is increasingly mainstream, especially in many of the minimally invasive procedural fields such as laparoscopic surgery, urology, catheter-based and endovascular surgery, and endoscopic surgery.

The use of simulation in medical education has been demonstrated to be cost-effective, improve learning efficiency, and increase skill retention rates.[9,10] In addition, skills obtained on the simulator are transferable to the bedside and applicable in a variety of clinical settings.[11] Another advantage to learning by simulation is that students can receive remedial feedback and learn from their errors.[12] From a patient-centered perspective, simulation has been demonstrated to enhance patient safety and comfort, thus decreasing the burden of procedure-related training.[13] The use of simulation in medical education includes expensive high-fidelity virtual reality simulation, relatively inexpensive inanimate models and mannequins, as well as usage of practical scenarios and drills to enhance procedural knowledge.

These revolutionary changes in competency-based education and assessment, along with web-based learning and the use of simulation in medical education, have led to an explosive level of research activity in many procedure-based fields. The procedural aspect of pulmonary medicine, however, has only recently embraced these educational models. The teaching of bronchoscopy, the pulmonary procedure most commonly performed by lung specialists, has been relatively unchanged since the 1970s. The apprenticeship model, based on the "see one, do one, teach one" paradigm, still remains the most common teaching mode for this procedure. A review of the pulmonary literature exploring the use of simulation, e-learning or competency-based education in the teaching and learning of bronchoscopy, returns few relevant studies. Results of these studies suggest the value of virtual reality simulation as an educational tool, with[14] or without[15] supervision, and the successful transfer of skills thus acquired to the clinical setting.[16] Other recent studies explore the use of competency-based education and assessment tools[17] as well as simulation[18] and web-based learning in bronchoscopy.[19]

It was in this milieu that Bronchoscopy International (BI) was established. Comprised of a growing group of international physicians, educators, researchers, information technology professionals, and allied health care workers involved in bronchoscopy practice and teaching, BI aims to assist healthcare workers in our field to excel in what we do, while decreasing the burden of procedure-related training on patients.[20] To achieve these aims, our intention has been to:

- Create a competency-based curriculum for learning and teaching bronchoscopy in a standardized manner.
- Design, develop, validate and apply evaluation tools that emphasize learning and objectively assess bronchoscopy skills and knowledge.
- Share our passion for knowledge and discipline in practice with the global bronchoscopy community, through commercially free, open-access web-based material.

The Essential Bronchoscopist© or EB© is one such curriculum of theoretic bronchoscopic knowledge, which was created by one of the authors (HC) with the collaboration of many expert bronchoscopists worldwide. It is a laddered, competency-based curriculum of basic bronchoscopic knowledge that can be accessed free of charge in five different languages: English, French, Spanish, Portuguese and Japanese. It has already been officially endorsed as a complementary educational tool by several national and international bronchology and pulmonary organizations (from Argentina, Singapore, Belgium, Malaysia, Spain, France, and Brazil, for example, as well as by the World Association for Bronchology). The EB© website is HON code certified (Health on the Net), and currently hosted by the University of California, Irvine (UCI).

The EB© is comprised of six modules, each with a module-specific competency-based learning objective, totaling 186 multiple-choice question-answer sets, viewable online (available at http://bronchoscopy.org/ under the link 'Essential Bronchoscopist') and also downloadable as PDF files. Each question-answer set contains information pertaining to the major topics represented in traditional textbooks of bronchoscopy (anatomy and airway abnormalities, patient preparation, indications, contraindications and complications, techniques and solutions to technical problems, lung cancer and infections, bronchoalveolar lavage, lung biopsy techniques, therapeutic and interventional bronchoscopy, anesthesia and medications, equipment and its maintenance, as well as history and education). The aim of the EB© is not to replace but to complement the conventional apprenticeship model of training in bronchoscopy by emphasizing important facets of knowledge and skill required for competency, and by encouraging trainees to discuss these with their preceptors and colleagues.

The complementary Bronchoscopy Step-by-Step© curriculum is comprised of a series of graded exercises created by the BI team to help learners gain the technical skills necessary for basic diagnostic bronchoscopy. These training maneuvers help the learner master incrementally difficult steps of bronchoscopy in eight measured exercises. The learner begins with practicing passage through the oral or nasal orifice to the larynx and then to the subglottis. The next steps involve navigating the central, lobar and segmental airways. The curriculum is meant to be used in a virtual reality simulator or on a mannequin with an airway model, although it can also be implemented on a consenting patient. It is designed based on the principles of enhancing 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.

By definition, competency-based education requires that each competency be teachable, learnable, and measurable.[21] Alongside the EB© and Bronchoscopy Step-by-Step© curricula, we have therefore designed assessment tools to measure basic bronchoscopic knowledge and technical skill. In a study conducted in Argentina and the US, we validated a method to select material from the question-answer sets of the EB©, which can be used to create tests of bronchoscopic knowledge.[19] In addition, in a prospective study we demonstrated the validity and reliability of two instruments used to test technical skill in bronchoscopy:[18] the Bronchoscopy Skills and Tasks Assessment Tool [BSTAT] and the Bronchoscopy Step-by-step Evaluation Tool

[BSET]. The BSTAT measures the skills of a bronchoscopist performing a diagnostic bronchoscopy, while the BSET has been specifically designed to measure performance on the Bronchoscopy Step-by-Step© exercises. Additional studies are ongoing, not only to improve on these learning instruments, but also to assess how they might be used by bronchoscopists working in different medical and cultural environments around the world.

Indeed, the novel developments that characterize medical education in the 21st century also come with new challenges and opportunities. Internet pioneer Vinton Cerf recently said, "Users are becoming the center of the universe. They are in charge. They are in control."[22] Considering the more than 900 million internet users in countries outside the United States, it is no longer acceptable to tolerate barriers that hinder the free flow of information. The immense body of medical knowledge and experience that has been created through the efforts of so many belongs to all patients, regardless of geography and financial status. Medical learners are, in fact, the users of knowledge, anxious to employ techniques and procedures that benefit their patients. We are all responsible to remove the obstacles which deprive medical professionals and their patients from beneficial knowledge. We owe it to every patient, to assure that they are protected from the burden of procedure-related training, while ensuring the highest possible level of procedural competency.

Acknowledgments: We thank Doctors Silvia Quadrelli (Argentina), Mauro Zamboni (Brazil), Jean-Michel Vergnon (France), Norihiko Ikeda and Patrick Barron (Japan) for their help with numerous translations of the Essential Bronchoscopist.

REFERENCES

1. Carraccio C, Wolfsthal SD, Englander R, et al. Shifting Paradigms: From Flexner to Competencies. Acad Med. 2002;77:361-367.

2. Miller GE. The Assessment of Clinical Skills/Competence/Performance. Acad Med. 1990;65:S63-7.

3. Martin M, Vashisht B, Frezza E, et al. Competency-based instruction in critical invasive skills improves both resident performance and patient safety. Surgery. 1998;124:313-7.

4. Schwarz, MR, Wojtczak A. Global minimum essential requirements: a road towards competence-oriented medical education. Med Teach. 2002;24:125-9.

5. Stillman PL, Wang Y, Quyang Q, et al. Teaching and assessing clinical skills: a competency-based programme in China. Med Educ. 1997;31:33-40.

6. Al-Chalabi TS, Al-Na'ama MR, Al-Thamery DM, et al. Critical performance analysis of rotating resident doctors in Iraq. Med Educ. 1983;17:378-84.

7. Davis MH, Harden RM. E is for everything – e-learning? Med Teach. 2001;23:441-4.

8. Smith R, Williamson A. BMJ journals free to the developing world. BMJ. 2002;324:444.

9. Seymour NE, Gallagher AG, Roman SA, et al. Virtual Reality Training Improves Operating Room Performance – Results of a Randomized, Double-Blinded Study. Ann Surg. 2002;236:458-64.

10. Scott DJ, Bergen PC, Rege RV, et al. Laparoscopic Training on Bench Models: Better and More Cost Effective than Operating Room Experience? J Am Coll Surg. 2000;191:272-83.

11. Park J, MacRae H, Musselman LJ, et al. Randomized controlled trial of virtual reality simulator training: transfer to live patients. Am J Surg. 2007;194:205-11.

12. Fried MP, Satava R, Weghorst S, et al. Identifying and reducing errors with surgical simulation. Qual Saf Health Care. 2004;13:19-26.

13. Sedlack RE, Kolars JC, Alexander JA. Computer simulation training enhances patient comfort during endoscopy. Clin Gastroenterol Hepatol. 2004:2:348-52.

14. Colt HG, Crawford SW, Galbraith O. Virtual reality bronchoscopy simulation: a revolution in procedural training. Chest. 2001;120:1333-9.

15. Moorthy K, Smith S, Brown T, et al. Evaluation of virtual reality bronchoscopy as a learning and assessment tool. Respiration. 2003:70:195-9.

16. Ost D, DeRosiers A, Britt EJ, et al. Assessment of a bronchoscopy simulator. Am J Respir Crit Care Med. 2001;164:2248-55.

17. Davoudi M, Osann K, Murgu S, et al. Systematic Validation of Two Instruments to Evaluate Technical Skills in Flexible Bronchoscopy Using a Virtual Reality Simulator. Chest Abstracts. 2006;130:166S-b.

18. Di Domenico S, Simonassi C, Chessa L. Inexpensive anatomical trainer for bronchoscopy. Interact CardioVasc Thorac Surg. 2007;6:567-9.

19. Davoudi M. Quadrelli S, Osann K, et al. Design of a Comprehensive Test of Bronchoscopy-Related Knowledge Using Question-Answer Sets from the Essential Bronchoscopist. Proc Am Thor Soc. Abstracts Issue. 2006;3:A292.

20. Bronchoscopy International. Accessed at http://bronchoscopy.org. On July 30, 2007.

21. Brasel KJ, Bragg D, Simpson DE, et al. Meeting the Accreditation Council for Graduate Medical Education competencies using established residency training program assessment tools. Am J Surg. 2004;188:9-12.

22. Personal communication at University of California, Irvine. 2007.