DOI: 10.1002/ppul.25311

COMMENTARY

PEDIATRIC PULMONOLOGY WILEY

Pediatric flexible airway endoscopy training during a pandemic and beyond: Bending the curve

Albin Leong MD, ATSF[1] | Dan Benscoter DO[2,3] | John Brewington MD[2,3] | Cherie Torres-Silva MD, MPH, MEd[2,3] | Robert E. Wood PhD, MD[2,3]

[1]Department of Clinical Sciences, Pediatric Pulmonology, California Northstate University College of Medicine, Elk Grove, California, USA

[2]Department of Pediatrics, University of Cincinnati College of Medicine, Cincinnati, Ohio, USA

[3]Division of Pulmonary Medicine, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio, USA

Correspondence

Robert E. Wood, PhD, MD, Cincinnati Children's Hospital Medical Center, MLC 7041, 3333 Burnet Ave, Cincinnati, OH 45229, USA.
Email: rewood@cchmc.org

Flexible airway endoscopy, for diagnostic and therapeutic purposes, is a vital aspect of pediatric pulmonology practice and has become an integral aspect of formal training in pediatric pulmonology. Achieving competency in flexible airway endoscopy requires mastery of several skills, including cognitive (learning anatomy, recognition of pathology, etc.), and manual (manipulating the instrument safely and effectively, etc.). To acquire the cognitive and manual skills of flexible airway endoscopy, there is no adequate substitute for direct procedural experience with patients. In pediatric pulmonology, the opportunities for such experience vary widely among training programs, many of which can offer only limited experience.

There are several potential barriers to training in pediatric bronchoscopy today. These include decreased procedure numbers due to the COVID-19 pandemic (and concerns for personnel safety); lack of access to centralized, formal training programs (also pandemic-related); and inadequacy of inanimate models and simulators for pediatric training.

The COVID-19 pandemic caused by SARS-CoV-2 has resulted in significant disruption to health care, including medical training.[1,2] As this virus is primarily transmitted by respiratory droplets, aerosol-generating procedures, especially bronchoscopy, pose a special danger to health-care workers. Multiple adult bronchology societies have issued guidelines about the risk of bronchoscopy and protection of health-care workers during the COVID-19 pandemic. All the guidelines recommend limiting the personnel present during the procedure, including those on patients not suspected of COVID-19, as well as prioritizing and limiting elective bronchoscopies. These guidelines acknowledge relying on consensus due to limited evidence of studies during this new and evolving pandemic.[3–5] The consequences of the pandemic include a potentially dramatic reduction in the opportunities for hands-on learning for pediatric pulmonology training. This could cause a significant educational gap for current fellows.

In the setting of caution on scheduling and performing aerosol-generating procedures and consequently restricted opportunities for hands-on experience, how can trainees develop proficiency in performing bronchoscopy? For surgical resident training, several alternative approaches have been proposed, including remote training platforms with prerecorded lectures, online practice questions, teleconferencing and telemedicine, procedural simulation, surgical videos, and developing competency tests.[6–8]

A survey of training in pediatric flexible bronchoscopy in the United States published in 2014 revealed that the apprentice model, with volume-based ascertainment of competency, was the primary method utilized by pediatric pulmonology training directors.[9] There are currently no evidence-based competency guidelines for pediatric flexible bronchoscopy. A suggested list of core competencies for pediatric flexible airway endoscopy is published in the Official ATS Technical Standards document.[10] In addition, the Supplement to the Technical Standards lists some tools for online learning of clinical assessment and performance from the American Thoracic Society, Bronchoscopy International, and a series on YouTube by Dr. Henri Colt, though these tools are primarily on adult flexible bronchoscopy (https://www.thoracic.org/professionals/clinical-resources/video-lecture-series/bronchoscopy/; https://bronchoscopy.org; https://www.youtube.com/user/bronchorg%23p/c/29BD464130B411C6/0/phRv73Ik7fI).

Studies in adult bronchoscopy training have shown variability in performance, and that procedure numbers are not a sufficient tool to assess competency. An expert panel on adult bronchoscopy training has suggested that "professional societies and certifying agencies move from a volume-based certification system to a standardized skill-acquisition and knowledge-based competency assessment for pulmonary and thoracic trainees."[11] In contrast, there is as yet no consensus statement about assessing competency, nor a standardized competency assessment tool for pediatric flexible bronchoscopy.

Computerized bronchoscopy simulators have been studied as a tool to develop competency (learning anatomy as well as manipulation of the bronchoscope). Several groups have reported that such simulation can result in the development of significant skills, and simulators can also provide a mechanism for assessing those skills, including attainment and maintenance of proficiency.[12–15] There are online virtual bronchoscopy simulation tools available, as well as commercial products (http://pie.med.utoronto.ca/VB/VB_content/simulation.html; http://www.thoracic-anesthesia.com/?page_id=2; https://www.intelligentultrasound.com/orsim-5/orsim-6/).

Simulation training in adult bronchoscopy has evolved. The American College of Chest Physicians (ACCP) has an innovative Bronchoscopy Certificate of Completion (COC) program designed for adult bronchoscopy, including cognitive as well as psychomotor skills for basic and advanced bronchoscopy involving transbronchial needle aspiration and endobronchial ultrasound utilizing simulation technology. The ACCP, with its Advanced Clinical Training Program, was the first society to receive accreditation from the Society for Simulation in Healthcare (https://www.chestnet.org/Education/Advanced-Clinical-Training/Certificate-of-Completion-Program/Bronchoscopy). The currently available virtual simulators, unfortunately, are not designed for pediatrics and are thus inadequate for pediatric training.

In addition to virtual simulators, cheaper alternatives with simple inanimate models have been used. Recently, more sophisticated and realistic models for adult bronchoscopy training have been developed utilizing 3D-printed airways. There is also the potential of using a 3D model of a specific patient case for preprocedural training and planning.[14,16,17]

Before the pandemic, many pediatric pulmonary physicians had taken a formal course, which has been offered in the United States since 1981 by Wood and colleagues; similar courses have been offered by other groups in Europe and Asia. These courses have included lectures, video presentations of anatomy and pathologies, and demonstrations as well as hands-on experience in various nonhuman models, and have been a vital aspect of initial training. However, the pandemic has resulted in classroom and hands-on training opportunities being currently prohibited; it is unclear when traditional training can resume, despite the initiation of vaccine distribution. The didactic material from the Cincinnati Children's Hospital Medical Center (CCHMC) course is now available online, by subscription, but hands-on training will remain a significant problem for the immediate future.

Traditionally, animal models have been used for initial training.[18] However, due to societal pressure and other factors, despite its advantages, the use of live animals for training purposes has fallen out of favor. The development of inanimate models for medical training has been a quantum leap forward, but models currently available commercially have serious limitations. Other models, appropriate for pediatric training, have been reported, but these also have significant limitations.[19,20] Inanimate models do not move, breathe, cough, secrete mucus, bleed, or require constant monitoring of the physiologic state of the "patient". On the other hand, a realistic model can be very useful for learning anatomy, manipulation of the bronchoscope, development of manual skills, and in the hands of an experienced instructor can be powerful. However, no inanimate model, no matter how realistic, can be a complete replacement for hands-on experience in human subjects.

At CCHMC, we have recently developed a high-fidelity model based on an 18-month-old child, using a combination of CT (computed tomography) scan data and artistic enhancement, guided by video recordings of pediatric bronchoscopy procedures and detailed iterative feedback from experienced pediatric bronchoscopists. This model includes the entire airway accessible to flexible bronchoscopes, from nostrils to 6th generation bronchi, and is anatomically highly accurate. There are realistic haptic qualities, and the model can be used for experience with bronchoalveolar lavage and clearing of secretions, as well as other interventional procedures. The first generation of this model was introduced for the 2019 Pediatric Flexible Bronchoscopy Course at CCHMC.

Teaching with a model should involve more than the development of manual skills in driving the instrument. The addition of clinically relevant scenarios to challenge students can be not only stimulating but vital to establishing an approach for the performance of bronchoscopy in patients.

The education of current and future trainees for pediatric flexible airway endoscopy is presently unsettled. The challenges of procedural medical training during the pandemic have necessitated different approaches to the traditional method of primarily apprentice training. In the relative absence of clinical experience, trainees will need more formalized didactic instruction regarding anatomy and pathology, as well as the basic psychomotor aspects of endoscopy. During this and any future pandemic or when a training program can offer only limited bronchoscopy experience, it is incumbent upon training directors to utilize all available opportunities for learning. These would specifically include models or simulators from our adult colleagues to give pediatric fellows the best possible training, even if this training is not specifically pediatric. This is a time of opportunity to capitalize on innovative solutions to adapt and improve future training, maintenance of cognitive knowledge, and psychomotor skills and their assessment, including developing standardized competency evaluation. Despite the pandemic, we must learn to bend the curve of training to adapt and progress.

AUTHOR CONTRIBUTIONS

Albin Leong: Conceptualization (equal); writing original draft (equal); writing review and editing (equal). **Dan Benscoter**: Writing review and editing (supporting). **John Brewington**: Writing review and editing (supporting). **Cherie Torres-Silva**: Writing review and editing (supporting). **Robert E. Wood**: Conceptualization (equal); writing original draft (equal); writing review and editing (equal).

ORCID

Robert E. Wood https://orcid.org/0000-0002-8137-9598

REFERENCES

1. Gordon M, Patricio M, Horne L, et al. Developments in medical education in response to the COVID-19 pandemic: a rapid BEME systematic review: BEME Guide No. 63. *Med Teach*. 2020;42:1202-1215.
2. Mallon D, Pohl JF, NASPGHAN Training Committee COVID-19 Survey Working Group, et al. Impact of COVID-19 on Pediatric Gastroenterology Fellow Training in North America. *J Pediatr Gastroenterol Nutr*. 2020;71:6-11.
3. Pritchett MA, Oberg CL, Belanger A, et al. Society for Advanced Bronchoscopy Consensus Statement and Guidelines for bronchoscopy and airway management amid the COVID-19 pandemic. *J Thorac Dis*. 2020;12:1781-1798.
4. Lentz RJ, Colt H. Summarizing societal guidelines regarding bronchoscopy during the COVID-19 pandemic. *Respirology*. 2020;25:574-577.
5. Wahidi MM, Shojaee S, Lamb CR, et al. The use of bronchoscopy during the coronavirus disease 2019 pandemic: CHEST/AABIP Guideline and Expert Panel Report. *Chest*. 2020;158:1268-1281.
6. McKechnie T, Levin M, Zhou K, Freedman B, Palter VN, Grantcharov TP. Virtual surgical training during COVID-19: operating room simulation platforms accessible from home. *Ann Surg*. 2020;272:e153-e154.
7. Chick RC, Clifton GT, Peace KM, et al. Using technology to maintain the education of residents during the COVID-19 pandemic. *J Surg Educ*. 2020;77:729-732.
8. García Vazquez A, Verde JM, Dal Mas F, et al. Image-guided surgical e-learning in the post-COVID-19 pandemic era: What is next? *J Laparoendosc Adv Surg Tech A*. 2020;30:993-997.
9. Leong AB, Green CG, Kurland G, Wood RE. A survey of training in pediatric flexible bronchoscopy. *Pediatr Pulmonol*. 2014;49:605-610.
10. Faro A, Wood RE, American Thoracic Society Ad Hoc Committee on Flexible Airway Endoscopy in Children, et al. Official American Thoracic Society technical standards: flexible airway endoscopy in children. *Am J Respir Crit Care Med*. 2015;191:1066-1080.
11. Ernst A, Momen, Wahidi MM, et al. Adult bronchoscopy training: current state and suggestions for the future: CHEST Expert Panel Report. *Chest*. 2015;148:321-332.
12. Veaudor M, Gérinière L, Souquet P-J, et al. High-fidelity simulation self-training enables novice bronchoscopists to acquire basic bronchoscopy skills comparable to their moderately and highly experienced counterparts. *BMC Med Educ*. 2018;18:191.
13. Kennedy CC, Maldonado F, Cook DA. Simulation-based bronchoscopy training: systematic review and meta-analysis. *Chest*. 2013;144:183-192.
14. Nilsson PM, Naur TMH, Clementsen PF, Konge L. Simulation in bronchoscopy: current and future perspectives. *Adv Med Educ Pract*. 2017;8:755-760.
15. Siddaiah-Subramanya M, Smith S, Lonie J. Mastery learning: how is it helpful? An analytical review. *Adv Med Educ Pract*. 2017;8:269-275.
16. Pedersen TH, Gysin J, Wegmann A, et al. A randomised, controlled trial evaluating a low cost, 3D-printed bronchoscopy simulator. *Anaesthesia*. 2017;72:1005-1009.
17. Ho BHK, Chen CJ, Tan GJS, et al. Multi-material three dimensional printed models for simulation of bronchoscopy. *BMC Med Educ*. 2019;19:236.
18. Wood RE, Pick JR. Model systems for teaching pediatric flexible bronchoscopy. *Pediatr Pulmonol*. 1990;8:168-171.
19. Hornung A, Kumpf M, Baden W, Tsiflikas I, Hofbeck M, Sieverding L. Realistic 3D-printed tracheobronchial tree model from a 1-year-old girl for pediatric bronchoscopy training. *Respiration*. 2017;93:293-295.
20. DeBoer EM, Wagner J, Kroehl ME, et al. Three-dimensional printed pediatric airway model improves novice learners' flexible bronchoscopy skills with minimal direct teaching from faculty. *Simul Healthc*. 2018;13:284-288.

How to cite this article: Leong A, Benscoter D, Brewington J, Torres-Silva C, Wood RE. Pediatric flexible airway endoscopy training during a pandemic and beyond: bending the curve. *Pediatric Pulmonology*. 2021;56:1386–1388.
https://doi.org/10.1002/ppul.25311