Interventional Pulmonary and Advanced Bronchoscopy Training

Benjamin DeMarco, Van K. Holden, and Hans J. Lee

Contents

Abstract

Interventional pulmonary (IP) and advanced bronchoscopy training occurs in various stages of a physician career. Competency had traditionally been developed in formal fellowship training with mastery developing over the entire career. With the rapid rate of new procedures, knowledge and procedures learned in fellowship may become obsolete requiring competency developed as a part of continuing medical education. New strategies of learning and teaching are being utilized in IP and advanced bronchoscopy in the face of an evolving subspecialty such as simulation, educational regulatory policies, and assessments.

Keywords

Interventional pulmonary · Fellowship · Training · Simulation · Continuing medical education

1 Introduction

The growth in medical procedures in interventional pulmonary and advanced bronchoscopy has been fueled by rapid infusion of technology. Traditionally, competency was developed during pulmonary/respiratory fellowship which would then allow for the pursuit of mastery till retirement. However, new procedures and technology have developed after traditional training which then require developing competency on new procedures as part of continuing medical education (CME) while pursing mastery in older procedures. Thus, the change in procedural training has become developing competency in IP/advance bronchoscopy procedures during fellowship and new procedures postfellowship as CME while pursing mastery in all learned procedures.

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2 Specialized Fellowship Training

2.1 History

The discovery and implementation of modern bronchoscopy is credited to German physician Gustav Killian and later, within the United States, Chevaliar Jackson. Education in bronchoscopy was initially grounded in the Halsteadian “see one, do one, teach one” model of apprenticeship, foundational to the graduate medical education system [1]. Driven by the growing popularity of the field, rapidly evolving technologies, and need for standardization of training in procedures outside the scope of general pulmonary and critical care medicine fellowship, interventional pulmonology (IP) training and education have undergone rapid growth in the last three decades. Training in IP focuses on the minimally invasive diagnosis and management of lung cancer, pleural disease, benign airway disease, and central airway obstruction with emphasis on specialized airway and pleural procedural training [2]. The approach and delivery of training varies based on location and the major formal training paradigms will be reviewed below.

IP training in the United States began with piecemeal training primarily from physicians traveling to Europe for apprenticeships in procedures such as rigid bronchoscopy and medical thoracoscopy or learning from other specialties such as thoracic surgery or otolaryngology. This disjointed system garnered a foothold for the subspecialty, but opportunities were rare and required significant individual sacrifice [3]. The first dedicated IP fellowship in the United States started in 1996. Over the next two decades, a multisociety effort driven by specialty medical societies has steadily advocated for and advanced formalized interventional pulmonology training in the United States. Key milestones in this growth and standardization are summarized in Fig. 1 and include the establishment of a centralized fellowship application system established by the Association of Interventional Pulmonology Program Directors (AIPPD), participation in the National Residency Match Program, development of a dedicated board certification exam, and most recently recognition as a new subspecialty by the Accreditation Council of Graduate Medical Education (ACGME) [4–8].

2.1.1 US Landscape

Currently, dedicated interventional pulmonology training in the United States requires a minimum of 1 year of additional clinical training within an accredited fellowship program following traditional pulmonary and critical care medicine fellowship. This training year is focused on imparting both standardized didactic knowledge requirements and specific procedural competencies. These tenants, in addition to institutional faculty, curriculum, and policy requirements, are articulated in the recently published ACGME common program requirements [8]. The knowledge-based requirements are assessed biannually with an inservice examination followed by a postfellowship board certification exam, currently administered by the AABIP. While there are ongoing society efforts to develop didactic resources dedicated to the core ACGME competencies of patient care, medical knowledge, and practice-based learning, much of this curriculum is currently left to the discretion of individual programs. As the number and variety of procedures necessary for trainees to be exposed to has increased, simulation has emerged as an important tool in IP and PCCM procedural education [9, 10]. Simulation technology allows trainees the opportunity for deliberate practice in a low-risk environment. Current literature suggests simulation can expedite the acquisition of basic bronchoscopic procedural skills, improve learner confidence, and reduce procedural time [11, 12]. Simulation technology can take several forms including virtual reality, low fidelity (mannequins, plastic models), and high fidelity (animal models, cadaver labs). High fidelity settings offer additional realism and immersion which must be balanced against higher costs, lower availability, and ethical considerations [2, 13]. Limited evidence suggests high fidelity simulation training may offer superior learning gain in novice trainees, but longer-term studies are needed [14]. A recent meta-analysis of simulation-based training in flexible bronchoscopy demonstrated positive effects of simulation training on learning in bronchoscopy, but heterogeneity in instructional design and assessment tools limited definitive conclusions on training efficacy [10]. Future research in simulation-based training is needed to explore skill transfer from simulation environment to direct patient care, optimal feedback methods for skill retention, and implementation of mastery-based assessments [15]. There is growing recognizance of the importance of simulation in an effort to advance the aforementioned manifesto of early medical education to “see one, simulate many, do one competently”; however, there are currently no specific guidelines or policies supporting a single simulation tool or preferred environment [15, 16].

In addition to didactic and simulation approaches, the current guidelines suggest a minimum volume of procedures that should occur at the primary clinical site to ensure adequate trainee exposure but stop short of defining assessment methods for validating competency. Validated assessment tools exist for some IP procedures (see Table 1) [24, 25], but implementation and utilization are heterogenous across fellowship programs. The transition from volume-based requirements to validated competency assessments is an ongoing need in IP education [26].

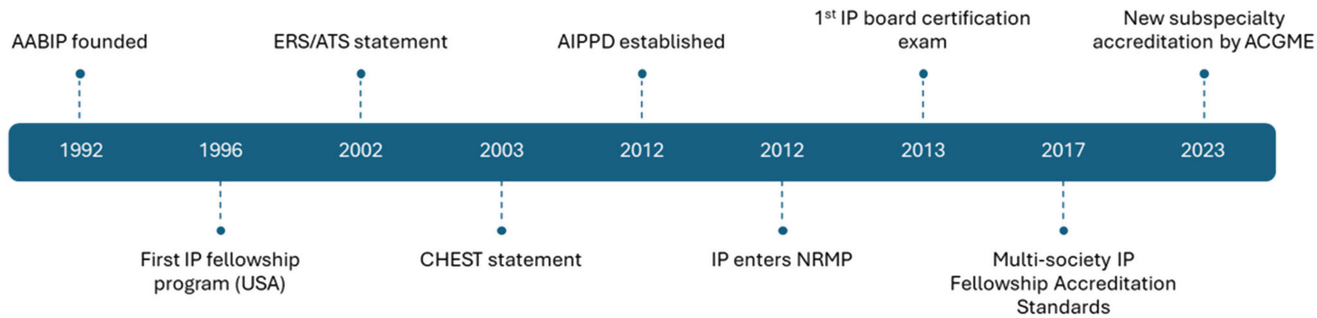

Fig. 1 Growth in interventional pulmonology (IP) fellowship education (1992–2023). AABIP, American Association of Bronchology and Interventional Pulmonology; ERS, European Respiratory Society; ATS, American Thoracic Society; CHEST, The American College of Chest Physicians; AIPPD, Association of Interventional Pulmonology Program Directors; NRMP, National Residency Match Program; ACGME, Accreditation Council of Graduate Medicine Education

Table 1 Procedural volume training requirements for IP and validated assessment tools

Procedure type	United States [6]	Europe [2]	Assessment tools
Rigid bronchoscopy	50	20	RIGID-TASC [17]
Endobronchial stenting	20	10	*None*
Thoracoscopy	20	10	Local anesthetic thoracoscopy (LAT) [18]
Bronchoscopic navigation	20	20	Electromagnetic navigation bronchoscopy [19, 20]
Endobronchial ablative techniques	50	20	*None*
Convex endobronchial ultrasound	100	50	EBUS-STAT [21]
US-guided thoracostomy tube placement	20	10	Checklist for assessing placement of a small-bore chest tube (CAPS) [22], chest tube insertion competency test (TUBE-iCOMPT) [23]
Tunneled pleural catheter placement	20		*None*

2.1.2 Global Perspectives

In contrast to the comprehensive North American model, Europe and other regions employ a shorter, procedure-specific accreditation model. This heterogeneity is driven largely by the wide variety of government regulatory and healthcare agencies across multiple European countries. The European Respiratory Society (ERS) introduced an EBUS and thoracic ultrasound certification program in 2016 that is widely recognized across the continent [27]. This program consists of a three-pronged approach to certification with didactic knowledge, clinical training, and supervised training components delivered through a combination of online learning, simulation, and direct observation. In addition, individual countries hold competence-oriented courses and structured “Masters programmes” (where a diploma is received at conclusion) of varying lengths and requirements.

In Germany, trainees received 12 months of training in tertiary care centers with simulation training followed by supervised hands-on training while the United Kingdom requires a procedural logbook spanning 5 years, with periodic review and supervisorial sign off. Italy has one of the most robust European training systems in the form of a master’s program built upon a standardized core curriculum agreed upon via consensus conference and supported by the European Association for Bronchoscopy and Interventional Pulmonology [28, 29]. The Italian curriculum encompasses procedure requirements as well as guiding principles for training methods, assessments, and specific knowledge and skills tied to necessary competencies. There is no single common curriculum or competence certificate unifying interventional pulmonology education in Europe, and master’s program diploma requirements, or lack thereof, differ by individual institutional requirements [30].

In other regions of the world, formal training for IP continues to develop. While no formal IP fellowship or accreditation standard exists, the Thoracic Society of Australia and New Zealand (TSANZ) has articulated competency standards for basic pleural procedures and thoracic ultrasound implemented through intermittent regional seminars [31]. In several South American and South Asian countries (India, Bangladesh, Algeria, Argentina), one-year bronchoscopy certification programs have been developed consisting of validated assessment tools combined with procedural log reviews, hands-on simulation training, and supervised clinical training.

Both North American and European interventional pulmonology training share the aim of expertise and eventual mastery through multidimensional competency-based training, although respective obstacles differ by location. All formal training is finite, however, and both maintenance of expertise and achievement of mastery in interventional pulmonology require continued learning throughout practice.

3 Continuing Medical Education

Interventional pulmonology training has become more formalized and standardized, moving away from an apprenticeship model; however, questions in continuing medical education (CME) remain. With the rapid implementation and expansion of new procedures within the field of advanced bronchoscopy and IP, physicians face the challenge of how to achieve and maintain new procedural competencies after formal training. This challenge is further intensified by the slower process of developing structured curricula, simulation, and assessment tools, which makes it difficult to determine parameters for competency and proficiency. Evaluations of patient safety and outcomes in clinical practice should also be evaluated after introduction of new skills. Specific skills once acquired may no longer apply for the entirety of one's career. Thus, physicians practicing advanced bronchoscopy and IP must employ lifelong learning to stay up to date in the application of new technology [29]. Collaboration between industry and national/international bronchoscopy organizations can help overcome barriers to acquiring this CME.

3.1 Challenges in CME

Training in IP can be organized into five stages (Fig. 2) [32]. Opportunities for postfellowship training include self-directed study, attending a course, participating in a mini-fellowship or observership, and/or being proctored. Courses and workshops are offered by multiple professional societies (AABIP, ACCP, ATS, ERS) and individual industry companies. Many of the workshops provide theoretical and practical training but lack consistent assessment in the remaining stages of training. In addition, any CME program aimed at updating physicians in practice should utilize teaching tools and methods to address the components of competency: (1) knowledge (knows), (2) clinical skills and capabilities (knows how to do), and personal attitudes and behaviors (knows how to act) [30, 33].

3.1.1 Theoretical Learning

In addition to textbooks, there are several more readily available web-based resources, such as e-books, websites, podcasts, and videos, for individual theoretical learning in IP training. Knowledge gained can be reinforced and applied through structured, multidimensional, and learner-centric educational programs [29, 32]. Course delivery has moved away from traditional lectures to more interactive practices, including the flipped classroom model, problem-based learning, live streaming, e-learning, and blended learning. In the flipped classroom model, lectures and reading material are provided to students online for independent learning prior to meeting in class. Then, class time is optimized to facilitate student-teacher engagement, such as problem- and case-based learning in which the teacher presents a problem or case to the class and acts as a facilitator or mentor. In addition, robust training programs employ a spiral-shaped approach, in which the same subject is approached many times, from new and different perspectives of knowledge, ability, and behavior until a high degree of skill is obtained [30]. Courses may assess knowledge acquisition by administering pre- and posttests.

3.1.2 Practical Learning Using Simulation

Workshops often employ low- and high-fidelity simulation. Manikins, three-diemnsional printed airway models, explanted porcine lungs, and cadavers have all been used for hands-on training. Artificial intelligence and virtual, augmented, and mixed reality simulators for bronchoscopy are being developed. Simulation is often utilized during single or multiday CME courses; however, they are not permanently accessible to learners afterward. Additional barriers to the use of simulation include their cost for acquisition, maintenance, and storage and a need for a structured curriculum with objectives [24, 34]. Furthermore, there is a lack of developed simulation for some procedures. Low- and high-fidelity simulators for robotic bronchoscopy are not commercially available. Limitations in postfellowship training include expertise of faculty, who need development to standardize curriculum delivery through train-the-trainer sessions [32].

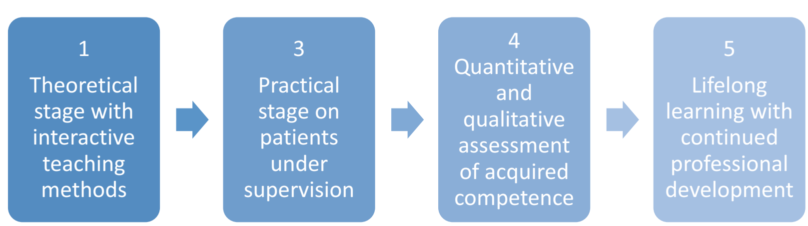

Fig. 2 The five stages of IP training

3.1.3 Practical Stage Under Supervision

The third stage includes a practical stage on patients under the supervision of a tutor, also known as proctoring. The degree and type of supervision will depend on the specific learning curve associated with each procedure and the individual physician's predisposition. Obstacles to proctoring learners in the clinical setting include medical-legal concerns and the need for hospital credentialing and malpractice coverage in some countries. Addition barriers include time constraints, expense, lack of awareness of available opportunities, and the lack of need to meet credentialing requirements at some institutions [35]. Also, different government regulatory agencies across countries do not uniformly recognize training [2].

3.1.4 Assessment of Competency

Procedural competency includes the ability to plan a procedure, obtain informed consent, deliver news of a diagnosis in a culturally sensitive and appropriate manner, communicate effectively with colleagues and patients, perform effectively as a team leader, and respond appropriately to procedure-related complications [29]. Best practices for quantitative and qualitative assessment of acquired competence and final certification remain unknown. External assessments are needed as self-assessment of competency is fraught with inaccuracy, especially among physicians who are the least skilled and those who were the most confident [36]. Procedural volumes do not ensure competency because of variable learning curves for different learners [37]. Thus, maintaining competence needs to evolve from being volume-based to competency-based. However, a paucity of validated procedural assessment tools makes this difficult. In addition, competency is an assessment at one point in time, and lifelong learning is essential to prevent skill decay. Novices trained to proficiency in doing bronchoscopy can have skill decay in as little as 2 months [38]. Interestingly, the minimum procedural volume needed for competency within a formal training program is usually not the requirement for hospital credentialing, which varies from place to place.

Challenges remain in determining competency, and thus how to achieve and measure it in continued medical education. Since competency is not as readily defined, especially without validated assessment tools, it is often left up to the discretion of individual hospital credentialing boards, for which a one-time course attendance may suffice. It is important to make a distinction between competency, certification, and credentialing, although the latter two are often conferred based on presumed competency. One-time workshops may provide a certificate of completion; however, this does not necessarily equate to competence. AABIP introduced a Certificate of Added Qualification in 2019 to assist in the recognition of competency for advanced diagnostic bronchoscopies. It consists of a knowledge assessment test and a procedural skills assessment test. The latter utilizes validated tools for proficiency in endobronchial ultrasound and peripheral bronchoscopy [39].

3.1.5 Continued Professional Development

The implementation of new technology is rapidly outpacing the development of structured curricula. Three robotic bronchoscopy systems have been FDA-approved and introduced into clinical practice over the span of 5 years alone [40]. There have been no studies evaluating if and how much of the skills learned for one system can be applied to another. Physicians need effective, efficient, and accessible methods to acquire and maintain new skills after training. Assessment of bronchoscopy skills and improvement in practice should be evaluated regularly after initial skill acquisition but is often lacking.

Distance learning with video recording assessment and feedback has been utilized in the European certification for EBUS and IP certification in China [41, 42]. The "pulmonary passport" project was developed in England to provide a web-based application for specialist respiratory trainees that allows standardized recording of procedures [43]. A Canadian multicenter registry of chest procedures is under approval to assess EBUS cases for suspected sarcoidosis, lymphoma, and lung cancer [44]. Physicians can develop their own logbook and document, including their reflection, results, and outcome [2].

Ongoing learning with opportunity for continuous improvement and possible periodic reassessment of skill levels (such as with advanced cardiac life support) and cognitive knowledge should be considered [9]. Methods for surgeons to engage in lifelong learning include simulation, coaching, and communities of practice [45]. These approaches could be extrapolated to IP but need to be studied. Physicians ultimately must learn how to reinvent themselves and stay current. Best practices in training in new technology after fellowship and maintaining competency remain to be determined. Although there are opportunities to address this gap, physicians and institutions must proceed with caution in the meantime.

3.2 Opportunities to Improve CME

There is significant time and investments in new technology before it becomes adopted. As these advancements evolve faster and faster, collaboration between industry and physicians is vital to ensure safe implementation of new technologies. This alliance can help with establishing structured training, validated assessment tools, and simulation. Working alongside expert educators, opportunities for scholarships include assessing learning curves, individual skill acquisition, and maintenance of competency. The European Society of Cardiology Board has proposed measures to safeguard the provision of high-quality, balanced medical education in working with industry [46]. Similar provisions could be applied to other fields, including IP. National/international bronchoscopy organizations can develop curriculum and establish a uniform approach to training, including guidelines, standards, and competency-based learning programs. The process of learning how to use new technology should be emphasized during formal training as part of lifelong learning to maintain professional standards.

4 Instructors and Mastery

The ultimate goal of medical education is to develop mastery. Mastery and the development of specific expertise is variable but requires years beyond formal training. A popular study on expertise found the timeline required 10,000 hours (approximately 10 years) for musicians to develop mastery [47]. This required not only length of years but more importantly the use of the concept deliberate practice. Deliberate practice requires intentional effort (without immediate reward) at the instruction of an expert coach. The coach would observe the performance and give specific feedback and goals for learners to independently practice till they have mastered the teaching point to return for additional observation and feedback. This has often been termed the "cycle of excellence" which is similar to other mastery models that have been developed for mastery performance [48]. For example, the puncture of a 2 cm lymph node with EBUS TBNA may demonstrate competency; an expert coach after observation may suggest refining skills on maintaining the EBUS bronchoscope still while feeding the TBNA needle in order to consistently biopsy a smaller target.

During formal fellowship training, we often receive coaching and feedback from faculty. In addition, the pool is much larger for faculty given the goal of competency does not require an expert proceduralist. However, when we examine models of mastery/expertise which would occur in the career phase after fellowship, we often need an expert coach/instructor of the task. The current metrics to define mastery is also challenging as mastery skills/experts often will not follow the set orders in a checklist assessment, oftentimes combining or skipping steps to become more efficient. The characteristic seen in experts is often a variable flow of concentration/effort giving their procedural tempo between automaticity and maximal effort. The use of biometrics may be a more suitable method for assessing expertise/mastery using metrics like pupillometry to measure maximum and minimum focus during specific portions of a procedure [49]. This becomes much more challenging and limited for CME. This may often lead to additional hours of procedural experience but may not normally include intentional effort and expert coaching to improve upon skill sets

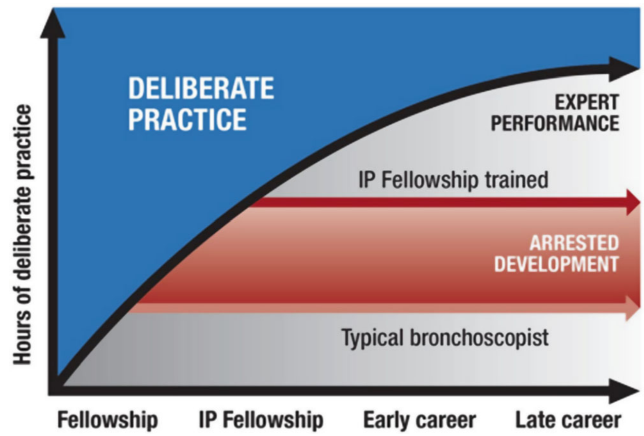

Fig. 3 Performance with deliberate practice over a Career [56]

leading to a plateau of performance ability, "arrested development" (Fig. 2) [48]. By having an expert coach or instructor, it allows intermediate practitioners to be observed of unconscious weakness. In essence, the coach and instructor bring out unconscious incompetence to become conscious incompetence which then allows the development to progress again.

The development of expert instructors has sparse discussion and studies in medical education. While there are multiple popular models for developing expert coaches, the challenge of finances/incentives, distance, and hospital credentialing are barriers [50]. Coaching techniques are based on live or video observation of procedures, followed by collaborative analysis, reflection, and goal planning with an expert, peer, or trained coach [51, 52]. Technical skills improvements have been reported using coaching techniques; however, long-term influences on nontechnical competencies such as overall performance and well-being are unclear in medicine. The use of video coaches/artificial intelligence using prerecorded performance and metrics has been used in surgical specialties and may offer a future solution for IP/advance bronchoscopy [53, 54]. Train the trainer programs have been developed in various subspecialties including in robotic surgery to give a structure educational program. The benefits of these programs are to deliver standardized training with common assessment metrics and ensure quality training on a large scale [55]. Regardless of the form of instructor/program/coaching development, some of the common traits include developing goal setting, motivation, assessment, and feedback skills (Fig. 3).

5 Conclusion

Training in IP and advance bronchoscopy has several stages over a career that has different emphasis over an entire career.

Competing Interest Declaration The author(s) has no competing interests to declare that are relevant to the content of this manuscript.

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