Standardizing education in interventional pulmonology in the midst of technological change

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Abstract: Interventional pulmonology (IP) is a maturing subspecialty of pulmonary medicine. The robust innovation in technology demands standardization in IP training with both disease and technology driven training. Simulation based training should be considered a part of IP training as seen in other procedural and surgical subspecialties. Procedure volume is a component of training; however, this does not guarantee or translate into competency for learners. Basic competency skills can be assessed using standardized well validated assessment tools designed for various IP procedures including flexible bronchoscopy, endobronchial ultrasound guided transbronchial needle aspiration (EBUS TBNA), rigid bronchoscopy and chest tube placement; however, further work is needed to validate tools in all procedures as new technologies are introduced beyond fellowship training. Currently there are at least 39 IP fellowship programs in the United States (US) and Canada which has led to improved training by accreditation of programs who meet rigorous requirements of standardized curriculum and procedural volume. The challenge is to be innovative in how we teach globally with intention and how to best integrate new evolving technology training for those not only during fellowship training but also beyond fellowship training.

Keywords: Interventional pulmonology (IP); deliberate practice; simulation; competency; fellowship; training; research; education; innovation; technology

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Introduction

Interventional pulmonology (IP) is a maturing subspecialty of pulmonary medicine with a focus on management of complex thoracic disorders with minimally invasive technology. IP encompasses the diagnostic and therapeutic approach of a variety of complex and challenging airway, lung and pleural disorders impacting patient outcomes and quality of life (1,2). The robust growth and innovation in technology with the emergence of new procedures including cryobiopsy, bronchoscopic lung volume reduction and robotic bronchoscopy have increased the diversity of interventional procedures offered. This has resulted in certification and formal training in IP throughout the globe. The United States (US), Australia, and some European nations have developed various forms of certification and formal training. China has recently developed national IP certification and designated accredited IP training centers. However, even with the recent adoption of formal IP fellowship training, the reality is that procedural training during fellowship only, will not last an entire career without learning new procedures and abandoning others learned during fellowship. The emphasis in modern fellowship training should incorporate methods to learn beyond...
fellowship training by collaborating with industry and global medical societies. Procedural training must evolve with technology.

Pulmonary medicine fellowship programs in the US and Canada typically do not provide the required number of interventional pulmonary procedures, with only about 30% of programs meeting the requirement (3,4). This creates an educational gap without defined standardized training and assessment of competency in performance of advanced airway and pleural procedures outside an IP fellowship. As a community of educators we are tasked to create a future best practice to fill this gap as discussed throughout this article. This is also true for pulmonary fellowship programs in Italy resulting in recognition of a 1-year fellowship in IP (5). Most US and Canadian IP fellowship programs provide a significantly higher number of basic and advanced interventional procedures than required by the American College of Chest Physicians (ACCP) and American Thoracic Society (ATS)/European Respiratory Society (ERS) guidelines (6). IP fellowship training in fact complements pulmonary medicine fellowship training and takes it to the next level.

Lahey Clinic (now Lahey Hospital & Medical Center, Burlington, MA, USA) was the first program to start a dedicated IP fellowship in the US in 1996, followed by an exponential growth in IP fellowship training programs over the last decade (7). There are existing opportunities to integrate training of specific procedures including advanced bronchoscopy in centers that have a pulmonary and critical care fellowship and IP fellowship programs. Currently 39 IP fellowship training programs in US and Canada participate in National Resident Matching Program (NRMP). The multi-societal accreditation of these programs as well as IP board certification, assures improved standardization in curriculum and procedural training. However, as newer technologies evolve, it becomes increasingly challenging to ensure competency beyond the scope of fellowship training.

**Simulation based training**

Simulation is an effective educational tool that facilitates repetitive training to improve psychomotor skills and assessment of decision making in a zero-risk environment. Simulation is being increasingly used in almost every industry with an ongoing growth and innovation in technology. Simulation and demonstration-based teaching has been found to be more effective than the classic didactics and lectures (8-10). Current evidence strongly suggests utilizing simulation in procedural training across all specialties (11). The American Board of Internal Medicine (ABIM) recommends simulation-based training as part of procedural training (12). The ATS and ACCP have strongly advocated including simulation in procedural training in pulmonary and critical care medicine (13). Patient-based procedural training (apprenticeship training model) alone may increase the risk of procedure-related complications and morbidity and brings up various ethical and liability issues. One study demonstrated that trainee participation in procedures can increase the procedure time and required dose of sedative medications with the resultant increase in risk of complications (14).

Simulation is an essential part of training in medicine and specifically the procedure-based specialty of IP (15). Simulation can be of various types including low- and high-fidelity simulation, complex task trainers, computer virtual reality, augmented reality (AR) models and real time simulated scenarios (16). Debriefing and immediate feedback have been shown to improve skills and performance (17). Studies have shown that simulation-based bronchoscopy and endobronchial ultrasound (EBUS) training is associated with improvement in skills and time management as compared to typical apprenticeship training model alone (18-25). Simulation based training has shown promising results in various procedural training specialties including thoracic surgery, congenital heart surgery, endoscopic surgery, colorectal surgery, neurosurgery, extracorporeal membrane oxygenation (ECMO), vitreoretinal surgery, cataract surgery and interventional radiology (26-34). Numerous studies have proven that trainee performance in achieving basic competency in airway management, tube thoracotomy, thoracentesis, central venous catheter (CVC) placement and diagnostic radiology improved after incorporating simulation-based curriculum (35-47). Simulation can span low fidelity to high fidelity virtual reality and augmented reality platforms for single learner to multi-team learning across multiple disciplines. These can be focused as procedure-specific, disease-specific with realistic patient driven scenarios. AR platforms are underutilized and can create a cost effective and global classroom with interactivity that brings a shared classroom real-time with a limitless number of learners to provide procedure-based learning with faculty mentorship.

Simulation-based boot camp training is being increasingly utilized in various subspecialties with a significant improvement in trainee knowledge, skills and confidence (48). The American Association of Bronchology
and Interventional Pulmonology (AABIP) has successfully arranged simulation-based boot camps at the beginning of each academic year for IP fellows in a flipped classroom model with the goal to improve education and training, as well as offer integrated online educational materials and IP specific symposia. A study showed that general pulmonologists and pulmonary fellows are less proficient in performing appropriate mediastinal staging using EBUS (49). To work towards a more standardized process and bridge this training gap, AABIP, ACCP and ATS host hands-on simulation procedure based training for pulmonary critical care fellows and general pulmonologists.

Although simulation-based training is important and should be part of the training curriculum, patient-based procedural training as an apprenticeship training model coupled with procedure volume are also necessary to establish competency that translates to successful independent clinical practice. Procedure volume has been shown to improve skill acquisition and proficiency in thoracic surgery as well as other procedure-based specialties (50). Simulation training is not meant to replace apprenticeship training but it should rather complement it.

Simulation training is a valuable option but there can be various barriers to its successful implementation including duty hour restrictions, scheduling problems and ongoing cost associated with buying and maintaining simulation equipment, a need for structured curriculum with objectives and having a simulation center facility and personnel. Simulation often lags behind as new procedures are developed. We need to collaborate with industry to establish models of training and create validated assessment tools for new technology.

**Competency and mastery learning**

A deliberate practice model with rehearsal and editing of specific tasks under supervision and constructive feedback has been shown to achieve mastery learning (51-53). Basic competence skills and expertise can be achieved after a routine training period but they plateau if deliberate practice model is not adopted (51-53). Most experts in various professions including sports and music reach mastery level by using deliberate practice over years. Deliberate practice of at least 10,000 hours over 10–15 years has been consistently shown to achieve mastery level performance (Figure 1) (54-56). Simulation may be very helpful in achieving mastery learning by utilizing a deliberate practice model. Spaced practice or distributed practice refers to spacing out training sessions over time rather than practicing in one long session (massed practice). Massed practice training sessions are long and intense as compared to spaced or distributed practice. For example scheduling two rigid bronchoscopy training sessions in subsequent days or weeks (spaced practice) as compared to both on the same day (massed practice). Spaced practice has been recognized as a more efficient learning model for trainees with better skill acquisition and long term skill retention as compared to massed practice (57). Spaced practice reduces mental fatigue, demands increased trainee effort to attain proficiency level at practice sessions and leads to better memory consolidation, with the subsequent efficient learning. Simulation and spaced practice have been shown to improve acquisition of skills with a decrease in surgical adverse events in laparoscopic surgery training (57-60). Continued learning with the goal to improve procedure skills beyond a year of IP fellowship training can be challenging. Simulation, video recording and distance learning may be helpful. It is also important to assess for skill maintenance and improvement on a regular basis after achieving initial procedural competency as acquired skills can be lost if a particular procedure is not performed, a phenomenon often referred to as skill decay (61,62). Procedure volume is important but does not ensure procedural competency, due to variable learning curves for different trainees (63). Procedural competency should be assessed using a standardized knowledge and skills assessment system rather than procedural volume alone.
(64,65). The concept of competency and mastery training in medical procedures mandate validated assessment tools to assess knowledge and technical skills of the learner at various points during training due to variable learning curve (66). Basic competency skills can be assessed using well validated competency assessment tools (Table 1). A newer validated procedure assessment tool is available to measure basic competency in electromagnetic navigational bronchoscopy and percutaneous transthoracic needle biopsy (67). Studies have shown a significant variation in endobronchial ultrasound guided transbronchial needle aspiration (EBUS TBNA) learning curve among IP fellows even after performing 200 procedures (63,68). RIGID-TASC (Rigid Bronchoscopy Tool for Assessment of Skills and Competence) is a validated tool to assess basic competency in performing rigid bronchoscopy (69). EBUS-STAT (Endobronchial Ultrasound Skills and Task Assessment Tool) is another reliable tool to evaluate knowledge and skills in EBUS-TBNA procedure (70-72). Various assessment tools have been developed to assess competency in flexible bronchoscopy including BSTAT (Bronchoscopy Skills and Task Assessment Tool), BSET (Bronchoscopy Step-by-Step Evaluation Tool) and OBAT (Ontario Bronchoscopy Assessment Tool) (73,74). Chest tube placement proficiency can be assessed using TUBE-iCOMPT (Chest Tube Insertion Competency Test) (75).

### Table 1 Procedures with validated assessment tools

| Procedure                                      | Validated assessment tool |
|------------------------------------------------|--------------------------|
| Rigid bronchoscopy                            | RIGID-TASC               |
| Flexible bronchoscopy                          | BSTAT, BSET, OBAT        |
| EBUS TBNA                                      | EBUS-STAT                |
| Chest tube placement                           | TUBE-iCOMPT              |
| Electromagnetic navigational bronchoscopy      | LEAP                     |
| Percutaneous transthoracic needle biopsy       | LEAP                     |
| Thoracic ultrasound                            | UG-STAT                  |

IP positions across various academic and non-academic institutions. IP training has become more standardized across the board due to a multi-societal accreditation process. The Association for Interventional Pulmonary Program Directors (AIPPD) and the AABIP have been instrumental in partnership with ACCP and ATS in promoting IP education and training through the formal accreditation process of IP fellowship programs, the IP board certification process as well as providing ongoing numerous opportunities in collaboration with industry for IP fellows through disease-specific and training-specific symposia.

An IP fellowship training curriculum should include (76-81);
- Structured formal didactics;
- Hands-on simulation-based training;
- Satisfactory procedure volume under faculty supervision and real time feedback;
- Quarterly review in a 360-degree fashion;
- Standardized curriculum.

A similar training model has been used in robotic surgery, cardiothoracic surgery and vascular surgery with improved procedural proficiency of the trainees (82-84). A proficiency-based progression training model using simulation training has been shown to improve skills and proficiency (85). The multisociety interventional pulmonology fellowship accreditation committee has published guidelines regarding IP fellowship accreditation standards to standardize IP training across various IP training programs (86). Table 2 lists the minimum institutional procedure volume required per year for accreditation of an IP fellowship program (86).

AABIP has conducted annual IP board certification examinations since 2013. Completion of a dedicated year of IP fellowship training at an accredited IP fellowship program has been a requirement for taking the AABIP board certification exam since 2017 (87,88). The IP in-service examination is a reliable tool to assess trainee knowledge and provide feedback to fellowship program directors regarding their training curriculum (89). In-service examination performance has been shown to strongly correlate with the performance on a subspecialty certification examination, irrespective of various other factors related to the fellow and fellowship program (90).

### Research and academic productivity

The importance of academic productivity and research cannot be overemphasized in any specialty. This is especially
true for IP given the robust growth in technology and minimally invasive procedures. The academic productivity of IP training programs has been comparable to other procedural specialties (91). Scholarly activity including multi-center research will have a great impact on further growth and recognition of IP. Allocation of specific research time throughout fellowship training with well-defined research goals and expectations can help improve academic productivity of IP fellowship programs (92,93). Dedicated research time for IP faculty is equally important and expert mentorship of young fellows and faculty can help in successful academic career development (94). We suggest additional scholarship in education, i.e., formal training in education, publications and research in cognitive load, decision making, curriculum development and mixed methods research.

**Ongoing education and training after fellowship**

Mastery in procedure skills is a dynamic ongoing process beyond a dedicated year of IP fellowship training. Excellence at performing a complex task e.g., playing violin requires an average of 10,000 hours of deliberate practice (95). Faculty mentoring extending beyond a year of IP fellowship training coupled with additional procedure specific training can be very helpful in professional development (76). The ongoing evolution and innovation in technology and research requires IP physicians to maintain and update their procedural skills on a regular basis far beyond fellowship training. Practicing IP physicians need to be competent and up-to-date in new technology and procedural interventions. Didactic teaching and hands-on training sessions including simulation workshops offered at professional society meetings (AABIP, Chest and ATS), short 1–2-day training courses and mini-fellowships extending beyond the extent of introductory courses may be helpful in achieving the goal of procedural proficiency in the era of technologic change and maintain high standard of practice.

**Recommendations**

We need to work closely with the industry for early
development of training models and formal training of new technology, using simulation and training courses. Encouraging distance learning with video recording assessment and feedback as seen in Europe and China can be an additional helpful option in achieving procedural proficiency.

**Conclusions**

The education and training in IP must be as innovative as the growing technology pushing this field forward. The use of augmented reality for global real time team based learning with video assessment/feedback, and simulators can allow IP practitioners to keep pace with technological changes. This will require the adoption of educators familiar with modern pedagogical practices and training. Program standardization and accreditation with both standard and flexible curricula, simulation-based training, continuous measures and ongoing assessment of competency skills will ensure progress toward sustained expertise and mastery.

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