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Original Research

INTERVENTIONAL PULMONOLOGY

Training for Linear Endobronchial Ultrasound Among US Pulmonary/Critical Care Fellowships

A Survey of Fellowship Directors

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Background: **Endobronchial ultrasound (EBUS) has revolutionized the ability of bronchoscopists to visualize and sample structures surrounding the tracheobronchial tree. It has been shown to be safe, minimally invasive, and highly accurate in the staging and diagnosing of mediastinal diseases. A prior survey of pulmonary fellowship program directors conducted in 2004 showed that only 2% of programs offered EBUS training.**

Methods: **Surveys were mailed to 154 pulmonary/critical care fellowship directors in the United States and Puerto Rico. Demographics of the fellowship and details of EBUS training were recorded. A comparison of EBUS volume was made between programs with and without an identifiable interventional pulmonologist (IP).**

Results: **The survey response rate was 71%. EBUS equipment was available at 89% of programs. Of those without EBUS, 100% expressed the goal of obtaining equipment within the year. An identifiable IP was present in 70% of programs. This was associated with more EBUS procedures performed by trainees ($P < .01$). Only 30% of programs have a formal protocol in place to evaluate EBUS competency. Conventional transbronchial needle aspiration is routinely taught in 89% of fellowship programs.**

Conclusions: **EBUS exposure has rapidly disseminated into fellowship training programs, and programs with an identifiable IP are more likely to provide fellows with more EBUS procedures. The findings of this survey point out the need to develop a standardized protocol for EBUS competency that includes current recommendations and may require training with simulation.**

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Abbreviations: ACCP = American College or Chest Physicians; EBUS = endobronchial ultrasound; IP = interventional pulmonologist; TBNA = transbronchial needle aspiration

Pulmonary and critical care medicine has seen vast improvements in technology develop over the past decade. Endobronchial ultrasound (EBUS) is one such technology that has revolutionized the bronchoscopist's ability to both visualize and sample structures surrounding the tracheobronchial tree. Over the past 10 years, there has been a growing body of medical literature. A PubMed search for publications including EBUS from January 2002 cited 479 references, with more than one-half of these published within the past 3 years.

EBUS first became commercially available in 1999 with the production of a flexible catheter with an ultrasound for application in the central airways.[1] This radial EBUS probe has a balloon tip that allows the

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ultrasound to have circular contact with the airway, thus providing a 360° view of the parabronchial structures. It was not until 2005 that the linear EBUS, or convex probe EBUS, which incorporated an ultrasound at the tip of a flexible bronchoscope, was marketed. The linear EBUS provided a new modality to sample parabronchial or paratracheal structures using transbronchial needle aspiration (TBNA) under real-time ultrasound guidance.[2]

With the advent of linear EBUS technology, the usefulness of the instrument for the staging and diagnosis of lung cancer and mediastinal disease became readily apparent. Numerous studies showed a specificity of 100%, a weighted sensitivity of 93%, and a false-negative rate of 9% for linear EBUS in mediastinal staging of lung cancer.[2-14] Two meta-analyses reported similar good results.[15,16] In addition, linear EBUS has more recently shown superior sensitivity for detecting mediastinal nodal metastasis when combined with surgical staging than does surgical staging alone.[17] Outside of lung cancer staging, linear EBUS has been shown to be a useful tool for the diagnosis of lymphoma and sarcoidosis.[18-20] With the increased demand for this technology, the availability of linear EBUS training in US fellowship programs has yet to be completely addressed.

In 2003, the American College of Chest Physicians (ACCP) published guidelines for all interventional pulmonary procedures including radial EBUS, with recommendations for a number of procedures needed for competency (n = 50).[21] It is important to note that there have been no established guidelines for a threshold number of procedures needed for competency in linear EBUS. Controversy remains on the use of a threshold number to achieve competency, and a survey conducted in 2004 demonstrated a large variation in the pulmonary procedures offered to trainees, with very few reaching numbers needed for competency.[22] At the time of this first survey, only 2% of pulmonary programs offered training in EBUS of any kind, none of which reached the numbers for competency.[22]

Within this context, and after 7 years and a robust body of literature supporting EBUS technology, we sought to determine what training is being offered to pulmonary fellows, how competency is being assessed, and whether the recommended threshold numbers of radial EBUS are being met. The collection of these data has implications in the design of the technical skill training curriculum for future pulmonary and critical care fellows.

Materials and Methods

A survey was developed by the authors at the Medical University of South Carolina by referencing the previous survey of program directors to ensure similar questions were used, to facilitate comparison. The survey inquired about the availability of EBUS equipment and further assessed how fellows are trained in EBUS. If a specific number of linear EBUS procedures was required for competency, this was recorded. In addition, seven questions were posed to assess the content of the respondent's fellowship program (see e-Appendix 1 for full survey). Following Institutional Review Board approval (IRB committee III, Pro00009849), surveys were distributed to program directors at the Association of Pulmonary and Critical Care Program Directors Seventh Conference and Workshop in Hollywood, Florida (March 26-27, 2011). In addition, three mailings were sent to the 154 accredited pulmonary/critical care fellowship programs in the United States and Puerto Rico listed by the American Medical Association. Surveys were mailed in April, June, and August 2011. If additional responses were received from the same program director, they were disregarded.

The number of procedures performed at programs with an identifiable interventional pulmonologist (IP) was compared with the number performed at institutions without an IP, using the Mann-Whitney *U* statistic. Of note, the definition of an IP was not specified on the survey and was left to the program director's interpretation.

Results

Surveys were mailed to 154 pulmonary/critical care fellowship program directors in the United States and Puerto Rico. A total of 110 surveys were returned (overall response rate, 71%). Table 1 demonstrates the characteristics of the fellowship programs, including the length of the program, the number of fellows, and the presence of an identifiable IP. Of the 110 responding program directors, 75 described their program as university hospital based, 17 as community hospital based, 91 as 3-year pulmonary/critical care programs, and two as pulmonary programs. Seventy programs (77%) had an identifiable IP on staff.

When queried about the availability of EBUS, 98 (89.1%) indicated that their institutions had EBUS equipment. Linear EBUS was performed by pulmonologists (94, 97%) and thoracic surgeons (31, 32%). Of the 12 programs without linear EBUS, 100% were interested in obtaining the equipment within the next 12 months. Ten program directors went on to answer further questions about obtaining EBUS. Eight (80%) had plans for EBUS to be added to the core fellowship curriculum, whereas two did not. Nine selected reasons for obtaining EBUS equipment, including to increase the competitiveness of the fellowship program (nine of nine), because EBUS is considered the standard of care for lung cancer staging (nine of nine), to improve local competitiveness (four of nine), and because a new EBUS-competent attending physician was available to train fellows (one of nine). These nine respondents also selected which training venue would be preferred for training faculty. The majority selected recruiting faculty trained in EBUS as the first choice, followed by a 3-month sabbatical and a course with animal laboratory.

Table 1—*Demographics of Fellowship Programs*

Characteristics	No. (%)
Fellowship program setting	
Community hospital	17 (15)
University hospital	75 (68)
Interventional pulmonary fellowship	
Yes	10 (9)
No	99 (91)
Identifiable IP	
Yes	77 (70)
No	33 (30)
Single attending physician supervising < 50% of bronchoscopies	
Yes	14 (13)
No	96 (87)
EBUS equipment available	
Yes	98 (89)
No	12 (11)
Staff performing EBUS	
Pulmonologist	94 (97)
Thoracic surgeon	31 (32)

Data are presented as No. (%). EBUS = endobronchial ultrasound; IP = interventional pulmonologist.

Of the 98 programs with linear EBUS, 93 program directors answered questions about fellow procedure competency. The majority (79, 85%) did not believe that an additional year of IP training was needed for competency, whereas 14 (15%) did endorse an additional year of training. Only two program directors (1.4%) who supported an additional year of IP training for linear EBUS were at institutions that offered an IP year.

Program directors from 28 institutions (30%) confirmed that a formal protocol was in place to assess fellow competency in linear EBUS, whereas the majority (65, 70%) indicated that there was not. Thirty-five of the 90 responding program directors (39%) noted that a specific number of EBUS procedures was included in evaluating fellow EBUS competency. The numbers ranged from 10 to 50, with 25 being the most commonly specified. The total number of EBUS procedures performed by those in training was significantly associated ($P = .01$) with the presence of an IP attending physician (Table 2). Despite training in linear EBUS, 75 out of 89 program directors (84%) indicated that conventional TBNA was routinely taught.

Discussion

This study has four major findings: (1) EBUS has rapidly disseminated into fellowship training programs; (2) the presence of an IP attending physician is associated with more procedures performed by fellows; (3) there remains no consensus as to who should undergo training in EBUS, how best they should be trained, and how procedural competency is best assessed; and (4) despite new technology, the majority of fellows are still trained in standard TBNA.

In 2004, when we first conducted a survey of program directors to assess training for interventional pulmonary procedures, only 2% of programs offered training in EBUS of any kind.[22] In 7 years, this number has risen dramatically to 89%. Given that linear EBUS has repeatedly been demonstrated to be safe, minimally invasive, and highly accurate for a broad range of mediastinal diseases, it is no surprise how rapidly the technology has disseminated into fellowship training.

Similar to our 2004 survey, we found that the presence of an identifiable IP attending physician was significantly associated with a higher total number of EBUS procedures done by fellows ($P = .01$). Since the 2004 survey, there has also been an increase in the number of identifiable IP attending physicians in fellowship training programs, from 53% to 70%. Of note, the definition of IP was not specified in the survey in 2004 or in the current survey to preserve question consistency and the ability to provide statistical analysis. We have no way of knowing whether a self-identified IP received training on the job, a formal 1-year fellowship, or a mini-sabbatical to an institution specializing in IP procedures. As the field continues to grow, better documentation of what constitutes an IP should be considered.

Whereas medicine subspecialties including gastroenterology and cardiology have long required a threshold number to achieve competency, it was not until 2002 that the European Respiratory Society and the American Thoracic Society released a consensus statement on interventional pulmonology.[23] Similarly, in 2003, the ACCP published guidelines for interventional pulmonary procedures.[21] The European Respiratory Society/American Thoracic Society guidelines for radial EBUS suggest that it is a procedure that should be reserved for those experienced in bronchoscopy because of the prolonged learning curve. Their recommendation is for participation in approximately 40 supervised procedures to first attain competency, with 25 procedures per year to maintain competence.

Table 2—*Average Number of EBUS Procedures Performed During Fellowship Training According to the Presence of an IP*

Presence of an IP	Average No. EBUS Procedures Performed: < 25	25-50	> 50
Identifiable IP	30	29	6
No identifiable IP	14	4	0
Total	44	33	6

See Table 1 legend for expansion of abbreviations.

It should be noted that these recommendations were made for the radial EBUS probe and not curvilinear EBUS. In a similar vein, the ACCP guideline acknowledges radial EBUS as a procedure requiring intensified training and practical experience and sets the competency threshold at 50 initially, with at least 20 per year for maintenance.

Because there are no formal recommendations for linear EBUS threshold numbers for competency, the recommendations for radial EBUS were used as a starting point for comparison in this analysis. It should be noted that the recommended competency numbers for radial EBUS in 2003 may not be directly applicable to curvilinear EBUS in 2012. However, were we to assume that 50 are required for competency, the threshold number is still not frequently met. Of the 83 program directors who reported the total number of EBUS procedures performed, only six programs (7%) reported that fellows had performed >50 EBUS procedures at the completion of training.

As with any new technology, estimates of the learning curve are important in determining time to competency. To calculate the learning curve for linear EBUS, a retrospective study from five centers in Europe was conducted using cumulative sum analysis.[24] The data demonstrated a wide range of time for attaining linear EBUS competency, with a pooled sensitivity of 67.4% for the first 100 cases of linear EBUS performed for the diagnosis or staging of lung cancer. This is significantly lower than the reported high sensitivities reported in clinical trials, supporting the between-hospital heterogeneity in obtaining a diagnosis with EBUS recently reported by the American College of Chest Physicians Quality Improvement Registry, Evaluation, and Education (AQuIRE) Bronchoscopy Registry.[25] In this prospective study, which included six centers in the United States, high-volume hospitals were associated with high diagnostic yields.

Establishing competency in bronchoscopy and associated interventional bronchoscopic procedures continues to be a subject of debate.[26] In the past, those in favor of a requisite number of bronchoscopies to become competent have relied primarily on expert opinion. There is a paucity of data to support these requisite numbers, as well as varying aptitudes among trainees, making the numbers difficult to standardize. Despite guidelines, consensus statements, and evidence of a prolonged learning curve, there remains no widely accepted method of assessing EBUS technical skill or competency.

Bronchoscopy simulators have been developed and validated for flexible bronchoscopy,[27] and, more recently, a linear EBUS simulator was validated for its ability to accurately discriminate among operators with different levels of clinical linear EBUS experience.[28] The simulator assessed performance based on metrics, including total procedure time, percentage of lymph nodes identified, and percentage successfully biopsied. Following validation, a study was conducted using the linear EBUS simulator to compare standard clinical training to simulation training in novice bronchoscopists.[29] Those who underwent simulation training had a significantly shorter procedure time and identified a higher percentage of lymph nodes successfully than did the group who had clinical training. Another prospective multicenter trial demonstrated that the use of educational interventions, including simulation training in bronchoscopy and a web-based bronchoscopy curriculum, enhances the acquisition of bronchoscopy skills among first-year pulmonary fellows, when compared with conventional training.[30] By no means do we advocate using a threshold number of 50 linear EBUS procedures to demonstrate competency. A combination of didactics, simulation training, and then clinical training may provide the best means to establishing technical skill and competency in linear EBUS trainees.

One area not addressed by this survey but fundamental to the instruction needed to achieve competency in any procedure is faculty training (How do we teach the teachers?). Although it is clear that more IP-trained physicians now populate fellowship programs, an evolution toward standardized procedural instruction is needed to ensure that trainees receive comprehensive technical education.

The role of continued training in conventional TBNA in pulmonary fellowship programs has been questioned with the availability of EBUS to guide TBNA. Although there has not yet been a randomized trial comparing diagnostic yield between linear EBUS and conventional TBNA, radial EBUS fine-needle aspiration has demonstrated superiority to standard TBNA in two randomized studies.[31,32] One study designed to compare three methods for the mediastinal staging of lung cancer, including standard TBNA, linear EBUS, and endoscopic ultrasound, found that linear EBUS is superior to TBNA for detecting malignant lymph nodes even at TBNA-favorable lymph node stations.[33] Similarly, the diagnostic yield of linear EBUS was shown to be superior to that of conventional TBNA in a randomized trial for the diagnosis of sarcoidosis.[34] Although 84% of responding program directors indicated that standard TBNA was part of routine training, EBUS continues its dissemination into pulmonary training programs and practices such that conventional TBNA may become obsolete.

Conclusions

In summary, the goal of a pulmonary/critical care fellowship program is to provide trainees with the best possible instruction in both the intellectual and procedural disciplines that define the specialty. The challenge of incorporating the latest diagnostic technology and skill training can be compounded by the cost of equipment, the availability of skilled faculty able to teach the procedure, and devising the best way to determine technical competency. It is clear that, over the past 7 years, the number of faculty skilled in EBUS and the availability of EBUS equipment have increased exponentially in fellowship training programs.

What remains is reaching a consensus on how best to equip fellows with the technical skill required to perform linear EBUS and how to assess competency. Although threshold competency numbers in linear EBUS do not presently exist and those for radial EBUS are not altogether evidence based and represent broad-based expert opinion, they do represent a starting point for training goals. As linear EBUS is called upon for applications beyond the diagnosis and staging of lung cancer, such as acquiring material for molecular analysis to guide treatment decisions, proficiency and skill in this technique will be in greater demand. Adding this technology to the armamentarium of bronchoscopy skills will provide fellows with a tool needed for success beyond training. The findings of this survey point out the need to develop a standardized protocol for linear EBUS competency that includes a recommended number of procedures, didactics, novel training in simulation, and clinical training.

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Additional information: The e-Appendix can be found in the "Supplemental Materials" area of the online article.

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