



Learning Experience of Linear Endobronchial Ultrasound Among Pulmonary Trainees

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Background: Linear endobronchial ultrasound (EBUS) allows real-time guidance of transbronchial needle aspiration of thoracic structures and has become an increasingly important diagnostic tool for chest physicians. Little has been published about the learning experience of operators with this technology. The purpose of this study was to define the learning experience of EBUS-guided transbronchial needle aspiration (EBUS-TBNA) among pulmonary trainees.

Methods: This was a multicenter cohort study of fellows in pulmonary medicine over the first 2 years of their training. Prior to performing EBUS-TBNA, all participants had to complete 30 conventional bronchoscopies, an EBUS-specific didactic curriculum, and a simulation session with a plastic airway model. Each consecutive EBUS procedure was scored with a checklist that evaluated the ability to pass a bronchoscope through vocal cords, identify the appropriate node for sampling, acquire adequate ultrasound images, guide the bronchoscopy team through the technical steps of EBUS-TBNA, and obtain adequate tissue samples.

Results: Thirteen pulmonary trainees from three training programs were enrolled in the study and were observed over a 2-year period. The majority of trainees were able to perform all essential steps of EBUS-TBNA and obtain adequate tissue after performing an average of 13 (95% CI, 7-16) procedures.

Conclusions: Pulmonary trainees needed an average of 13 procedures to achieve first independent successful performance of EBUS-TBNA following a training protocol that included a didactic curriculum and simulation-based practice. Our findings could guide pulmonary fellowship directors in planning EBUS training and establishing a reasonable juncture to assess EBUS skills with validated assessment tools.

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Abbreviations: EBUS = endobronchial ultrasound; EBUS-TBNA = endobronchial ultrasound-guided transbronchial needle aspiration; ROSE = rapid on-site evaluation; TBNA = transbronchial needle aspiration

Linear endobronchial ultrasound (EBUS) was introduced over the last decade as an innovative tool that incorporated an ultrasound probe at the tip of a flexible bronchoscope, allowing real-time guidance of transbronchial needle aspiration (TBNA) of various mediastinal, hilar, and peribronchial structures. Data on EBUS quickly accumulated demonstrating its safety and efficacy in the diagnosis and staging of lung cancer, sarcoidosis, and other benign causes of mediastinal and hilar lymphadenopathy.^{1,2} The demonstrated efficacy of EBUS-guided TBNA (EBUS-TBNA) has fueled a widespread interest in EBUS among chest physicians, which, in turn, created an urgent need to understand

the training required to achieve competency in this procedure for both established practitioners and trainees.

There is a paucity of literature that has specifically addressed EBUS-TBNA training.³ There is no consensus on how best to train clinicians in EBUS or how to assess procedural competency, including what is an appropriate minimum threshold number of procedures. National societies have published number-based guidelines for interventional pulmonology procedures; however, these were largely based on expert opinion and predated the availability of linear EBUS technology and, therefore, focused on radial EBUS, a fundamentally different type of EBUS procedure.^{4,5} Several

studies evaluating the learning curve for EBUS-TBNA among established clinicians have been published.⁶⁻⁸ A small retrospective study evaluated the learning curve of EBUS-TBNA based on diagnostic sensitivity among two thoracic surgeons and found it to be about 10 procedures.⁸ A prospective Australian study demonstrated that the diagnostic performance of EBUS-TBNA among two pulmonologists improved significantly by 20 procedures but did not peak until after 50 procedures.⁶

An even more pressing need is the determination of the training requirements of EBUS-TBNA among pulmonary trainees to ensure adequate training of future chest physicians. A recent survey of Pulmonary and Critical Care Medicine Program Directors reported that 89.1% of institutions had EBUS equipment.⁹ Of those programs that did not currently have equipment, 100% were interested in obtaining it in the next 12 months. However, only 30% of these programs had a formal protocol in place to assess fellow competency in linear EBUS. The purpose of our study is to prospectively evaluate the learning experience of pulmonary trainees performing EBUS-TBNA and to determine the average required number of procedures to perform the essential steps of the procedure and successfully obtain a tissue diagnosis.

MATERIALS AND METHODS

This was a multicenter cohort study of fellows in pulmonary medicine with an observation period of 2 years. Study protocols were approved by each institution's review board. Thirteen fellows from Duke University Medical Center, Medical University of South Carolina, and Virginia Commonwealth University Medical Center were followed for a 2-year period starting at the first day of their pulmonary fellowship. At the beginning of the study period, each participant completed a survey to assess their interest and prior experience in bronchoscopy, including experience with conventional flexible bronchoscopy, specific experience with EBUS-TBNA, and perceptions related to EBUS bronchoscopy.

Prior to performing their first EBUS-TBNA procedure, all fellows were required to complete 30 conventional bronchoscopies and participate in a didactic and hands-on training on EBUS-TBNA. This consisted of a standardized lecture on EBUS-TBNA provided

by faculty with experience in EBUS bronchoscopy and an hour-long period of supervised practice of EBUS-TBNA on an inanimate plastic airway model (Olympus Corp).

Fellows performed EBUS procedures under the direct supervision of an attending physician with experience in EBUS-TBNA and were evaluated on EBUS-TBNA performance via a checklist. The checklist included five steps that were deemed essential for the successful performance of EBUS-TBNA. These steps included the following: ability to pass the EBUS bronchoscope through the vocal cords, ability to identify the appropriate lymph node for initial sampling (based on highest stage of staging procedure or ease of access in context of diffuse disease), ability to identify the target lymph node and/or mass with ultrasound on command without assistance, ability to guide the team in the bronchoscopy suite through the steps necessary to operate the needle and perform EBUS-TBNA, and ability to obtain adequate samples as determined by rapid on-site evaluation (ROSE). The fellow had to complete all five steps with no assistance to be recorded as successful EBUS-TBNA performance. If the fellow could not complete one of these steps independently or required assistance by the supervising attending physician, then the procedure was recorded as unsuccessful performance of EBUS-TBNA. The supervising attending physician was instructed to take over the procedure if any of these steps were missed by the fellows. Additionally, if ROSE determined that adequate sampling was not accomplished by the fellow, the attending physician completed the procedure to assure that adequate sampling occurred. Other data collected for each procedure included patient data (indication for procedure), procedural preparation data (presence or absence of artificial airway and agents for sedation/anesthesia), and sampling data (lymph node station sampled, estimated size of lymph node sampled, total number of TBNA passes attempted by the fellow and/or attending physician, preliminary diagnosis by ROSE, and final pathologic diagnosis).

Statistical Analysis

The primary survival analysis related the number of EBUS-TBNA procedures to the percentage of fellows completing all EBUS-TBNA steps. The procedures from 13 fellows were used in the analysis. Of the 13 fellows, 11 completed all EBUS-TBNA steps by the end of the study. The two fellows who did not complete all EBUS-TBNA steps by the end of the study had censored observations in the analysis. The two vertical hash marks on the graph (Fig 1) are plotted at the number of EBUS-TBNA steps completed by the two fellows with censored observations. The rate of missed data points was 16%, with the majority of missed procedures being related to two fellows who performed procedures at a VA Medical Center. Analysis calculations were performed using SAS Proc Lifetest, version 9.2 (SAS Institute Inc).

RESULTS

Bronchoscopy Experience and Demographics

Table 1 summarizes the participating fellows' demographics. It also illustrates their prior experience in conventional and EBUS bronchoscopy and perception about EBUS bronchoscopy.

EBUS-TBNA Procedural Details

Indications for the EBUS-TBNA procedure consisted of undiagnosed hilar and/or mediastinal lymphadenopathy (46%), pulmonary nodule/lung mass/mediastinal mass (24%), additional sampling for lung cancer (4%),

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