Cost-Effectiveness of Initial Diagnostic Strategies for Pulmonary Nodules Presenting to Thoracic Surgeons

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Background. **Patients presenting to thoracic surgeons with pulmonary nodules suggestive of lung cancer have varied diagnostic options including navigation bronchoscopy (NB), computed tomography-guided fine-needle aspiration (CT-FNA), ^{18}F-fluoro-deoxyglucose positron emission tomography (FDG-PET) and video-assisted thoracoscopic surgery (VATS). We studied the relative cost-effective initial diagnostic strategy for a 1.5- to 2-cm nodule suggestive of cancer.**

Methods. **A decision analysis model was developed to assess the costs and outcomes of four initial diagnostic strategies for diagnosis of a 1.5- to 2-cm nodule with either a 50% or 65% pretest probability of cancer. Medicare reimbursement rates were used for costs. Quality-adjusted life years were estimated using patient survival based on pathologic staging and utilities derived from the literature.**

Results. **When cancer prevalence was 65%, tissue acquisition strategies of NB and CT-FNA had higher quality-adjusted life years compared with either FDG-PET or VATS, and VATS was the most costly strategy. In sensitivity analyses, NB and CT-FNA were more cost-effective than FDG-PET when FDG-PET specificity was less than 72%. When cancer prevalence was 50%, NB, CT-FNA, and FDG-PET had similar cost-effectiveness.**

Conclusions. **Both NB and CT-FNA diagnostic strategies are more cost-effective than either VATS biopsy or FDG-PET scan to diagnose lung cancer in moderate- to high-risk nodules and resulted in fewer nontherapeutic operations when FDG-PET specificity was less than 72%. An FDG-PET scan for diagnosis of lung cancer may not be cost-effective in regions of the country where specificity is low.**

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The management of pulmonary nodules suggestive of lung cancer is a combination of art and science as the clinician balances the advantages and disadvantages of a range of tests at each stage in the diagnostic process. The US Preventive Services Task Force recently recommended low-dose computed tomographic (CT) screening of healthy individuals at high risk for lung cancer [1]. Based on current smoking estimates in the US population and given the rates of nodule discovery found in the National Lung Screening Trial, as many as 1 to 2 million more suspicious nodules will be discovered annually given current clinical screening recommendations [2]. Patients with suspicious nodules will require additional tests for diagnosis, and some will require evaluation by a surgeon.

Currently, ^{18}F-fluoro-deoxyglucose positron emission tomography (FDG-PET) is suggested for noninvasive diagnosis of a nodule larger than 0.8 cm with a clinical probability for lung cancer between 5% and 65%. Computed tomography-guided fine-needle aspiration (CT-FNA) is an alternative diagnostic technique with a diagnostic accuracy of 77% (range, 59% to 96%) in peripheral nodules accessible to needle biopsy; however, as many as 41% of CT-FNA biopsies are nondiagnostic [3].

Several image-guided bronchoscopy techniques have been developed to improve the yield of transthoracic and transbronchial biopsy for lung nodule diagnosis. Computer-assisted navigation bronchoscopy (NB), virtual bronchoscopy, and radial endobronchial ultrasound allow the clinician to navigate beyond the hilum to biopsy suspicious lesions in the peripheral lung fields with increased diagnostic yield [4, 5]. Using a decision analysis model, we examined the cost-effectiveness of NB compared with FDG-PET, CT-FNA, and video-assisted thoracoscopic surgery (VATS) biopsy.

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Abbreviations and Acronyms

CT-FNA = computed tomography-guided fine-needle aspiration
FDG-PET = ^{18}F-fluoro-deoxyglucose positron emission tomography
ICER = incremental cost-effectiveness ratio
NB = navigation bronchoscopy
QALYs = quality-adjusted life years
VATS = video-assisted thoracoscopic surgery

Material and Methods

A decision analysis model was developed to estimate the costs and outcomes of four different diagnostic strategies for the workup of a patient with a 1.5- to 2-cm nodule detected by CT. Compared strategies included FDG-PET scan, NB, CT-FNA, and surgical biopsy (Fig 1). The model includes key outcomes after each treatment or diagnostic alternative with estimated probabilities of these events, quality-adjusted life years (QALYs), and total costs associated with each strategy. Model construction and cost-effectiveness analysis were performed using TreeAge Pro 2013 (Williamstown, MA). This study was not deemed human research by Vanderbilt Institutional Review Board.

The base case is a 60-year-old man with a 15-pack-year smoking history, no prior history of lung cancer, and a 1.5- to 2-cm nodule in an upper lobe incidentally observed on a CT scan. The nodule is either spiculated or has grown at least 15% in diameter on serial radiographs, but does not have both radiographic risk factors. The individual is a good operative candidate and would tolerate a lobectomy. With a clinical risk for lung cancer of approximately 65% based on the Mayo Clinic model, this case reflects a patient presenting to thoracic surgeons for surgical evaluation for suspected lung cancer without a preoperative diagnosis [6]. Several diagnostic choices are available to the surgeon for diagnostic workup of this patient who is at the margin between high and intermediate risk for lung cancer [7]. A second base case

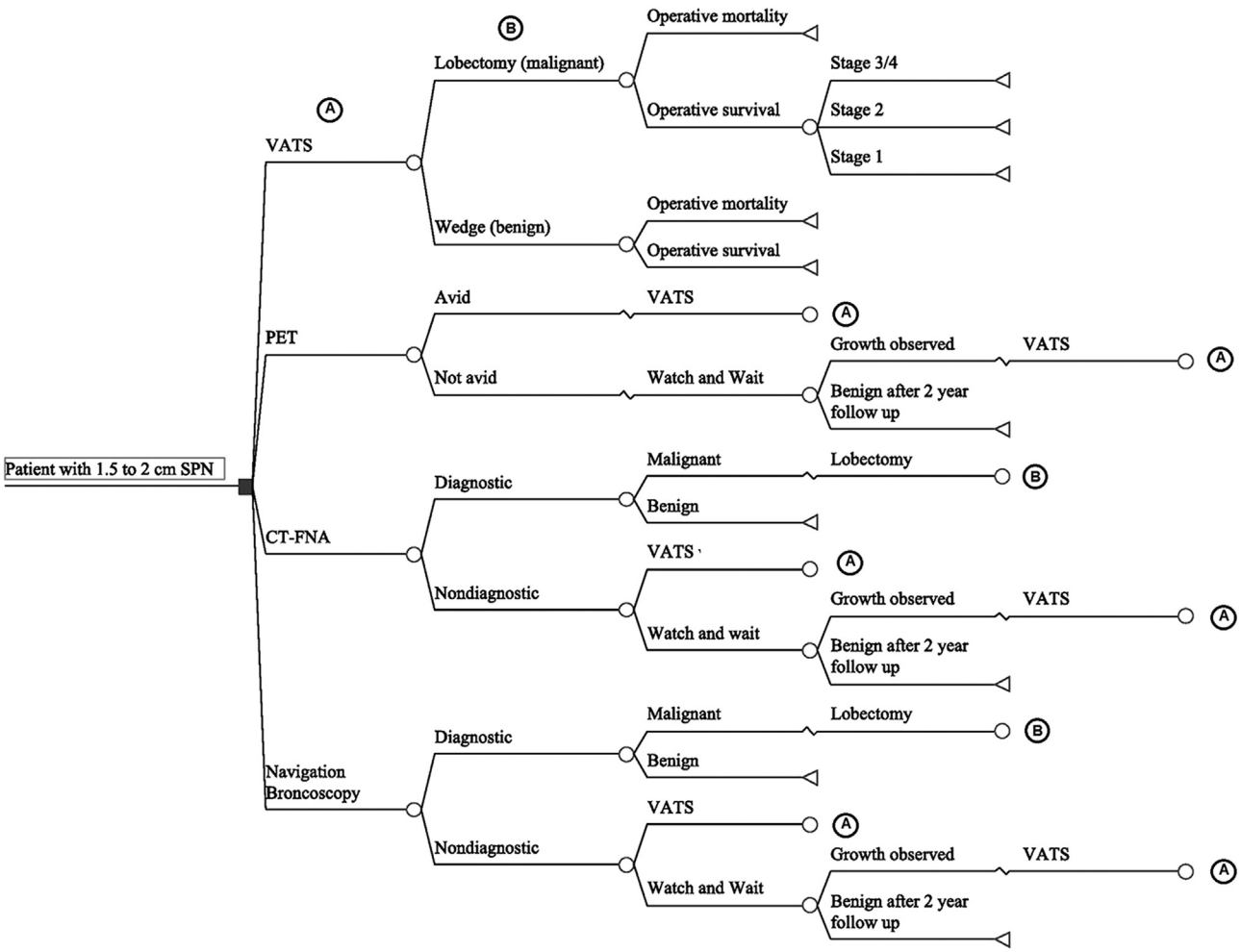

Fig 1. Decision analysis model for patient presenting with a 1.5- to 2-cm nodule and likelihood of lung cancer is 65%. (A = outcomes resulting from a video-assisted thoracoscopic surgery [VATS] biopsy; B = outcomes resulting from a lobectomy given pathologically determined malignancy; CT-FNA = computed tomography-guided fine-needle aspiration; PET = positron emission tomography; SPN = suspicious pulmonary nodule.)