A performance and theoretical cost analysis of endobronchial ultrasound-guided transbronchial needle aspiration in a UK tertiary respiratory centre

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Summary

Background: New innovative techniques can improve patient care but may not be appropriately funded. Endobronchial ultrasound-guided transbronchial needle aspiration (EBUS) offers a minimally invasive mediastinal staging and diagnostic method for suspected lung cancer.

Aim: We report the performance and cost analysis of a newly established EBUS service in a prospective real world cohort of patients to assess the impact of Payment by Results (PbR).

Design: Prospective cohort study.

Methods: Fifty-four patients between June 2008 and April 2009 underwent EBUS for evaluation of unexplained mediastinal lymphadenopathy on CT. Cost analysis was performed from local Trust financial data and 2008–09 tariffs.

Results: EBUS had an 89% sensitivity, 75% negative predictive value and 92% accuracy for malignancy. EBUS coding was inaccurate in 15.6% of cases. The actual cost of an EBUS is £1252–1433 but is coded as a standard bronchoscopy (£561). EBUS reduces health community costs by £107824/year, as a result of a Primary Care Trust cost saving of £113968/year and a Trust cost deficit of £6144/year. Coding inaccuracies further alter the Primary Care Trust costs.

Conclusions: Medical innovation is fundamental to improved patient care. EBUS can potentially reduce morbidity for lung cancer patients and save health community costs. However, with PbR the service provider delivers this at a loss as the tariffs do not reflect innovation and because of coding inaccuracies. We suggest tariffs for innovative procedures need to reflect the true cost.

Introduction

Endoscopic ultrasound-guided transbronchial needle aspiration (EBUS) offers a minimally invasive method of sampling mediastinal nodes to stage and diagnose lung cancer compared with conventional surgical staging techniques of cervical mediastinoscopy (CM) and/or anterior mediastinotomy (AM).\(^1\) In the absence of distant metastases, staging of mediastinal lymph nodes is pivotal to treatment decisions and it is often necessary after radiological staging. EBUS offers potential advantages over CM including access to the hilar nodes, reduced morbidity, local anaesthesia, a day case procedure, the absence of a neck scar and cost savings.

A recent systematic review of eight EBUS studies and 23 CM studies confirmed EBUS has a 90% overall sensitivity (compared with 78% for CM), with a 76% overall negative predictive value for malignancy (compared with 89% for CM), although the
disease prevalence of malignancy was significantly lower in the CM studies (39 vs. 68% for EBUS) which might account for the lower sensitivity of CM.2

The cost effectiveness of EBUS (as an example of an innovative minimally invasive technique) has not yet been formally evaluated and there are no published studies on the coding allocation applied to EBUS. Health care systems operating by Payment by Results (PbR) need to adopt an appropriate EBUS tariff. EBUS may take significantly longer than a standard bronchoscopy, requires two skilled operators in most centres and via ultrasound enables a detailed assessment of parabronchial mediastinal nodes and masses to be made which can then be sampled. Thus it may be argued that a mediastinoscopy tariff (£2584) is more appropriate than a standard bronchoscopy tariff (£561) which is currently used to reimburse most EBUS procedures.3 Some individual centres have negotiated a local EBUS tariff arrangement with their primary care trusts (PCT). The main health community cost savings for the use of EBUS are likely to be in the avoidance of surgical staging procedures. Recent studies have demonstrated the ability of EBUS to do this with avoidance rates of between 28 and 56%.4–7 One theoretical cost analysis in a UK centre suggested that EBUS would not be cost saving to the Trust (~£26 000 cost to Trust per year despite £59 000 cost saving to the PCT), until the tariff is updated.8

Therefore, PbR can stifle innovation by inadequate costing of new innovative, techniques resulting in the perpetuation of older, more expensive but appropriately remunerated procedures which may be more invasive and have more morbidity. These same issues apply to other specialties. It is possible that now common procedures, such as laparoscopic hernia repair or laparoscopic cholecystectomy, would have been harder to develop in a tariff-based era.

The learning curve for EBS is short. Centres who have recently set up an EBUS service have reported results only slightly inferior to a systematic review. Koh et al. reported a sensitivity of 83%, negative predictive value of 67% with EBUS for discrete nodal enlargement (lymph node metastasis prevalence 75%) in an Australian prospective study of 38 patients.9

We describe the learning curve and utility of a recently developed EBUS service in a prospective performance analysis in a UK tertiary respiratory centre. We have also conducted a theoretical cost analysis based on the actual coding of the EBUS procedures to assess the impact of PbR on developing EBUS.

Methods

Over a 10-month period from June 2008 to April 2009, 54 patients underwent day case EBUS for investigation of unexplained mediastinal lymphadenopathy on CT scan (and/or PET scan). EBUS was performed with a convex probe and real-time sampling (Olympus Keymed) with four passes undertaken per nodal station via a 21-gauge needle, sampling at the highest nodal station first under topical local anaesthesia and conscious sedation (intravenous fentanyl and midazolam). No rapid on-site cytology was available and samples were sent to cytopathology and histopathology in liquid cytology medium and formalin.

The Trust HRG coding for each patient episode was reviewed retrospectively i.e. the ‘actual’ HRG codes applied to all EBUS procedures was independently performed after the coding had been completed. The ‘predicted’ HRG codes were derived from the National Tariff 2008–09 and for EBUS we postulated that the ‘predicted’ code would be HRG D05 (£2584 for 2008–09) a mediastinoscopy code (as this is the closest representation to this procedure), as there was currently no specific EBUS tariff at that time. ‘Predicted’ (as expected from the National Tariff) and ‘actual’ (as actually coded on the system by the NHS Trust coders) costings according to the PbR tariff were derived from the selected HRG codes.

Actual NHS costings were calculated based on local Trust NHS financial data. These costings took into account the cost of the equipment, running and staff costs. The equipment (approximate costs are given in pounds sterling ex VAT in parentheses) required essentially includes the EBUS bronchoscope (£55 000), the ultrasound processor (£30 000 up to £55 000 depending on utility) and one disposable EBUS needle per patient (£175 each). Other costs include the maintenance contract (£5–8000) and staffing costs.

The theoretical number of EBUS procedures per year was calculated by extrapolation of the average number per month performed in the study period. The number of mediastinoscopies performed (because of a non-diagnostic EBUS) was calculated using the observed sensitivity of EBUS in the study. Costings accounted for the proportion of EBUS procedures where a combined normal bronchoscopy was performed to take endobronchial biopsies (32.5%).
Data were analysed by GraphPad Prism (version 4) software and assessed for normality using the Ryan–Joiner test. Tariffs and loss/gain data are represented as mean with standard error in parentheses. Sensitivity and negative predictive value for EBUS were calculated. A positive EBUS result was taken as true positive and not followed by mediastinoscopy.

Results

Fifty-four patients were referred for EBUS, 15 (27.8%) were tertiary referrals from outside the Leicester region. All were successfully performed as a day case with no requirement for overnight admission. The mean (se) age of patients was 66.3 (1.5) years with 50% male and 50% female. CT scans were available in all patients and PET scans were performed in 19 (35.2%) with a mean (se) mediastinal node SUV of 7.3 (0.7), range 2.5–16. Lymph node diameters ranged from 1 to 3 cm.

Three patients attended but did not undergo sampling: patient 1 did not have any significant adenopathy at EBUS (subsequent mediastinoscopy was normal with normal sized nodes), patient 2 developed intractable coughing and had sub-1cm nodes (subsequent mediastinoscopy was also normal), patient 3 vomited bile at the time of topical anaesthesia despite having been fasted and EBUS was abandoned for fear of aspiration (subsequent mediastinoscopy confirmed NSCLC at 10R and 4R). No complications occurred related to EBUS sampling.

The diagnostic utility of EBUS for suspected malignancy is shown in Figure 1. Four patients had a false negative EBUS (on the basis of enlarged mediastinal nodes on CT at least with a lung primary mass and therefore a clinical diagnosis of lung cancer, in the absence of histology). One patient had a mediastinoscopy confirming small cell lung cancer from a 4R nodal mass (no PET performed), three patients had enlarged multi-station mediastinal lymph nodes.
lymph nodes but were too unwell for a mediastinoscopy. We have assumed, in the presence of clinically suspected lung cancer and enlarged mediastinal nodes on CT that a false negative EBUS result had occurred for the purpose of stringency, although only histologically proven in one of the four cases. Figure 2 shows the breakdown of nodal stations sampled with the commonest locations being station 7 and 4R and a predominance of N2 nodes. The mean (se) number of nodal stations sampled was 1.7 (0.1) per patient (range 0–3).

Table 1  HRG coding allocations for EBUS procedures

<table>
<thead>
<tr>
<th>Parameter</th>
<th>No (%)</th>
<th>Tariff (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRG D07</td>
<td>44 (84.6)</td>
<td>561</td>
</tr>
<tr>
<td>HRG D03</td>
<td>5 (9.6)</td>
<td>4090</td>
</tr>
<tr>
<td>HRG D14</td>
<td>1 (1.9)</td>
<td>2238</td>
</tr>
<tr>
<td>HRG D25</td>
<td>1 (1.9)</td>
<td>1058</td>
</tr>
<tr>
<td>HRG E36</td>
<td>1 (1.9)</td>
<td>632</td>
</tr>
</tbody>
</table>

HRG D07 corresponds to standard bronchoscopy tariff.

HRG coding inaccuracies occurred as displayed in Table 1. In total, 84.6% of EBUS coding episodes were ‘correct’ (assuming the standard bronchoscopy code as a surrogate for EBUS). The calculated cost to the health community of running an EBUS service vs. a conventional mediastinoscopy service is shown in Table 2 with the relative costs to the PCT and the Trust. The actual cost of an EBUS is significantly higher than a conventional bronchoscopy (£1252–1433 vs. £383, respectively) but the tariff for all these procedures is £561. Table 3 shows a theoretical cost analysis based on the scenarios of EBUS coded as a bronchoscopy tariff and a mediastinoscopy tariff to illustrate the differences of tariff application to health community costs and relative effects on PCT and Trust costs. The higher tariff reduces cost savings to the PCT but also improves cost savings for the Trust. Table 4 shows the effect of EBUS coding inaccuracy as well as tariff variation on PCT costs. As the overall result was a slightly higher tariff then cost savings to the PCT were reduced.

Table 2  Actual costs of procedures to Trust and tariff-based revenue from PCT to Trust

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimated NHS cost per procedure (£)</th>
<th>Theoretical 2008–2009 PCT cost (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mediastinoscopy</td>
<td>3008</td>
<td>2581</td>
</tr>
<tr>
<td>EBUS</td>
<td>1252</td>
<td>Not known^a</td>
</tr>
<tr>
<td>EBUS with standard bronchoscopy</td>
<td>1433</td>
<td>Not known^a</td>
</tr>
<tr>
<td>Standard bronchoscopy</td>
<td>383</td>
<td>561</td>
</tr>
</tbody>
</table>

^aNo official EBUS tariff as of 2008–09.

Table 3  Annual cost savings to NHS, PCT and Trust with/without EBUS and according to EBUS tariff coding

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mediastinoscopy only (no EBUS)</th>
<th>EBUS (bronchoscopy tariff)</th>
<th>EBUS (mediastinoscopy tariff)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost to PCT (£/year)</td>
<td>165 376</td>
<td>51 408</td>
<td>180 880</td>
</tr>
<tr>
<td>Cost to NHS (£/year)</td>
<td>215 360</td>
<td>107 536</td>
<td>107 536</td>
</tr>
<tr>
<td>Cost saving to NHS (£/year)</td>
<td>n/a</td>
<td>107 824</td>
<td>107 824</td>
</tr>
<tr>
<td>Cost saving to PCT (£/year)</td>
<td>n/a</td>
<td>113 968</td>
<td>−15 504</td>
</tr>
<tr>
<td>Cost saving to Hospital Trust (£/year)</td>
<td>−49 984</td>
<td>−6144</td>
<td>123 328</td>
</tr>
</tbody>
</table>

Table 4  Effect of coding inaccuracy on cost/cost saving to PCT according to EBUS tariff used

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cost/patient (£)</th>
<th>Cost/year (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (se) actual cost to PCT (HRG code applied) for EBUS</td>
<td>944 (148)</td>
<td>75 920</td>
</tr>
<tr>
<td>Mean (se) loss/gain compared with predicted (mediastinoscopy) tariff for EBUS</td>
<td>−1641 (148)</td>
<td>−105 024</td>
</tr>
<tr>
<td>Actual PCT saving (compared with EBUS coded as bronchoscopy tariff)</td>
<td>−383</td>
<td>−24 512</td>
</tr>
<tr>
<td>Actual PCT saving (compared with EBUS coded as mediastinoscopy tariff)</td>
<td>16 540</td>
<td>104 960</td>
</tr>
</tbody>
</table>
Conclusions

We have reported a sensitivity of 89% with EBUS for malignancy, negative predictive value of 75%, accuracy of 92% with a disease prevalence of 74% comparable to published studies and demonstrating there is a short learning curve. Further evidence that EBUS has a short learning curve comes from the high sensitivity obtained from other centres recently establishing an EBUS service. A recent systematic review of eight EBUS studies reported similar results to our study with a 90% sensitivity and 76% negative predictive value, although our mean prevalence was slightly higher (74 vs. 68%, respectively). Three studies from established EBUS centres have examined patients with enlarged mediastinal nodes on CT reporting slightly higher sensitivities of 94–5% which may be accounted for by the equipment, the difficulty of the procedure, the structures being sampled) as well as the advantages to patients in avoiding more invasive procedures.

Thoracic surgeons are a limited resource. The variability of UK lung cancer resection rates may reflect the variable surgical input to lung cancer MDTs across the UK depending on availability. Respiratory physicians outnumber thoracic surgeons significantly and EBUS can be learnt by competent bronchoscopists. EBUS can reduce pressure on thoracic surgery capacity by reducing mediastinoscopies and improve patient care by offering a minimally invasive alternative and potentially reducing time to diagnosis (if surgical staging capacity is saturated).

We acknowledge the limitations of this study. First, it is a single centre study in a tertiary UK respiratory centre (in the context of interventional pulmonology) with heterogeneous cohort of patients referred. However, although the pre-test probability of lung cancer was variable, this heterogeneity reflects real world practice and the purpose of our study was to assess the clinical and cost impact of a newly developed EBUS service in a real world setting relevant to other centres wishing to develop this.

Second, there are potential issues regarding the tariff calculations. We have referred to the 2008–09 NHS tariffs in our calculations which have now been superseded by the 2009–10 tariffs with a Planned Same Day (PSD) Tariff for all day case procedures. We have also assumed all mediastinoscopies were day case in our calculations (to purposely underestimate our cost savings with EBUS although we are aware that a small percentage of mediastinoscopy patients required admission). We have postulated that a mediastinoscopy tariff (or at least a tariff meeting the actual costs of EBUS) is the most appropriate for EBUS on the basis that both procedures are used to sample mediastinal lymph nodes. This principle has been accepted in other UK centres and PCTs and Trusts have agreed their own tariffs following local negotiation.

Third, we (like many other studies in this field) did not validate all positive EBUS results with mediastinoscopies and we therefore acknowledge that there is a small potential for false positive results which has been documented in the few studies that have addressed this (mean 0.7% rate). In summary, we have demonstrated a recently developed EBUS service can deliver performance utility for malignancy non-inferior to published systematic review of EBUS studies. It is likely for the current time that the EBUS tariff will be near to a standard bronchoscopy tariff and EBUS is therefore likely to be cost saving to the NHS and the PCT but cost generating for the Trust. The magnitude of this will also depend on the degree of coding inaccuracy we have noted. We suggest that the tariff for innovative minimally invasive procedures (such as EBUS) needs urgent review and amendment to take account of the actual cost of the procedure (which encompasses the technical advance, cost of the equipment, the difficulty of the procedure, the structures being sampled) as well as the advantages to patients in avoiding more invasive procedures.

The EBUS procedures were coded variably with at least 15.4% of HRG codes inaccurate. EBUS costs the Trust £6144/year if coded as a bronchoscopy, although it is cost saving to the NHS (£107 824/year) and the PCT (£113 968/year). These cost savings vary if taking into account EBUS coding inaccuracies and alternative tariff applications.

Coding inaccuracies are not a new phenomenon. The Audit Commission have found variations between 0.3 and 52% across Acute Trusts in England in coding variation and a recent UK study noted significant coding errors of nearly 70% for thoracoscopy. Errors are therefore particularly common in areas of innovation and intervention so our findings regarding EBUS are unsurprising in this respect. There is also currently no EBUS tariff further complicating the issue, highlighting the need for HRG planners to consider innovation. Minimally invasive techniques such as EBUS need to be costed and appropriately remunerated. We therefore suggest the EBUS tariff should be promptly amended by HRG planners to the region of £1252–1433 and make allowance for whether an additional conventional bronchoscopy has to be performed. The 2009–10 changes to PBR will result in further reduced costs to the PCT for all day case procedures although this may make EBUS more financially attractive to Trusts as the drop in PBR revenue from mediastinoscopy is likely to be far greater than for EBUS.

Thoracic surgeons are a limited resource. The variability of UK lung cancer resection rates may reflect the variable surgical input to lung cancer MDTs across the UK depending on availability. Respiratory physicians outnumber thoracic surgeons significantly and EBUS can be learnt by competent bronchoscopists. EBUS can reduce pressure on
with increased morbidity (such as mediastinoscopy). Until such time, other centres may be deterred from setting up such new innovative services on cost grounds despite obvious benefits to patients.

Acknowledgements

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Conflict of interest: None declared.

References