

**CLINICAL FORUM**

## Cost analysis of video-assisted thoracic surgery *versus* thoracotomy: critical review

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*Cost analysis of video-assisted thoracic surgery versus thoracotomy: critical review. P. Van Schil. ©ERS Journals Ltd 2003.*

**ABSTRACT:** Cost containment has become an important issue in thoracic surgery. Applying the principles of evidence-based medicine a literature search was performed to determine whether video-assisted thoracic surgery (VATS) has an advantage over thoracotomy concerning total cost.

Only eight studies specifically looked at cost; all but one were retrospective. Lung biopsy by VATS yielded higher operating room costs compared with limited thoracotomy. The cost of VATS wedge resection of lung nodules was competitive with open techniques. In a prospective study regarding the treatment of pneumothorax by VATS, no advantages were demonstrated compared with axillary minithoracotomy. In two retrospective studies the total economic cost of VATS was lower but not all relevant factors were considered. Lung volume reduction surgery by VATS had a lower total inpatient cost compared with sternotomy but no specific details were provided. Finally, VATS treatment of lung cancer yielded conflicting results regarding total hospital charges.

From these studies it is clear that video-assisted thoracic surgery has a higher initial cost. Whether this is offset by a more rapid discharge remains to be proven. There is a definite need for high-quality prospective randomised studies.

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Although thoracoscopy is not a new procedure, a revival was seen from 1991 onwards, parallel with the widespread implementation of laparoscopic video-assisted techniques. The term "video-assisted thoracic surgery" (VATS) was introduced and it should be emphasised that it is essentially a new approach to thoracic disorders. Potential advantages are smaller incisions that are more cosmetic, less pain, a shorter hospitalisation time, earlier recovery and therefore a lower total cost. Possible disadvantages are a potentially less adequate operation due to limitations of the monitor and instruments, a high initial cost due to more expensive equipment, including many disposable instruments, loss of digital palpation of the lung, and often unknown long-term results [1].

Cost containment has become an important issue. When looking at the principles of evidence-based medicine the most valid information comes from prospective randomised trials. When these have consistent results, level I evidence is available and grade A recommendations can be made [2]. Regarding the cost analysis of VATS *versus* thoracotomy, many factors must be taken into account (table 1). Regarding the cost of equipment, the total cost, comprising the camera, video monitor, thoracoscope and light source, should be calculated. Disposables include nonreusable thoracoscopic instruments; most of the latter cost comes from endostaplers and cartridges. Operating room charges not only include the operating room time but also the cost of anaesthesia and double-lumen tube or bronchial blocker.

Concerning the morbidity of VATS, the occurrence of new complications, such as port site metastases should be incorporated as well as the use of other devices such as a Heimlich valve and any outpatient management. Late

complications include recurrent pneumothorax and its subsequent management. Ideally, economic outcome determinants, recovery of function and return to work should also be considered.

The cost of equipment and disposables is higher for VATS than for open procedures. Conversely, a VATS procedure may yield a more rapid recovery and a shorter hospital stay such that the total economic cost could be lower than for an open procedure. A literature search was performed to determine whether there is a clear answer to this question according to the principles of evidence-based medicine.

Table 1. – Important factors in cost analysis of video-assisted thoracic surgery (VATS)

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Preoperative
Selection criteria for VATS (procedures)
General hospital charges (hospitalisation)
Operative
Cost of equipment
Cost of disposables, operative time, operating room charges
Postoperative
Morbidity of different procedures
Mortality of different procedures
Duration of chest-tube drainage
Length of stay, outpatient management
Long term
Long-term results
Treatment of late complications
Economic outcome determinants

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## Methods

As VATS was introduced in 1991, a Medline search was performed from 1990 to March 2003 with the keywords "cost" and "thoracoscopy" or "VATS". Those articles in which the cost issue of VATS was addressed in relation to an open procedure were selected. As many different interventions are possible by VATS, these were divided in subgroups according to the specific manuscripts available.

## Results

Only eight studies specifically addressed cost analysis [3–10] (table 2). Seven of these were retrospective and only one was prospective but nonrandomised [7]. Thus, the only available information comes from nonrandomised series with different and sometimes conflicting results. Concerning the specific thoracic procedures a distinction was made between lung biopsy, excision of lung nodules, pneumothorax, lung volume reduction surgery (LVRS) and lung cancer. One manuscript studied the cost of VATS treatment for lung nodules and for lung cancer, and will be discussed under both relevant headings [5]. Regarding other thoracoscopic interventions *e.g.* thoracic sympathectomy or pericardial fenestration, no specific studies on cost issue are available.

### Lung biopsy

In a retrospective study published in 1994, 37 consecutive patients who underwent an elective lung biopsy for interstitial lung disease were studied; 16 had a lung biopsy by a VATS procedure and 21 by a limited thoracotomy [3]. There was no difference in mortality, duration of operation, time to removal of thoracic drains, amount of analgesics or length of hospitalisation. The latter was relatively long with a mean of 4.8 days for VATS and 5.0 days for thoracotomy. Operating room charges and anaesthesia-related costs were significantly higher in the VATS group. The authors of the study concluded that these higher procedure-related costs with VATS were concerning because of the absence of any clear patient benefit.

### Excision of lung nodules

In a retrospective study from 1993, VATS wedge resection of lung nodules (n=45) was compared with an open technique (n=31) [4]. Anaesthesia costs were similar in both groups. The cost for disposables was higher in the VATS group but the

operative time was less and therefore there was no difference in total operating room cost. Mean hospital stay for VATS was 4.4 days and for an open procedure 6.5 days, resulting in lower hospital charges in the VATS group. However, this difference was nonsignificant. Thus, the cost of a VATS wedge resection was found to be competitive with that of an open technique in this retrospective study.

In a similar, more recent Japanese study, 30 VATS excisions of lung nodules were compared with 20 open procedures [5]. Again, the cost of disposables was higher but the operative time shorter for a VATS procedure. The length of hospital stay was also shorter for a VATS resection (10.4 days) compared with an open procedure (16.8 days), but it was excessively long for this kind of procedure. As a result, the total hospital charges were lower in the VATS group.

### Pneumothorax

In a comparative retrospective study of 60 patients, costs of VATS and thoracotomy were analysed in patients operated on for a primary or secondary pneumothorax [6]. A variety of surgical procedures was utilised ranging from bullectomy and pleurectomy to abrasion only. Compared with limited thoracotomy, operating time, length of hospitalisation and day of chest-tube removal were shorter in the VATS group. The total cost of VATS was 22.7% lower than in the thoracotomy group. However, in the VATS group the cost of the video equipment was not calculated [11]. Moreover, the groups were small and not homogeneous. A secondary pneumothorax was present in 40% of patients in the thoracotomy group compared with 26.7% in the VATS group. Bullectomy and pleurectomy were more often performed in the thoracotomy group suggesting more extensive bullous disease, which could already induce a longer hospital stay in this group. One patient died in the thoracotomy group after a prolonged stay; this could also influence overall hospital stay and cost. Recurrent pneumothorax was more frequent in the VATS group (6.6%) than in the thoracotomy group (0%), with a shorter follow-up time in the VATS patients.

For a primary pneumothorax, should VATS not be compared with a more limited transaxillary approach instead of a classical lateral thoracotomy? In a prospective but non-randomised study of 66 patients with a persisting or recurrent pneumothorax, 36 patients had a VATS procedure and 30 were operated on by way of a transaxillary minithoracotomy [7]. The choice of the specific procedure was made by the patients themselves. No advantage of VATS was shown in operating time, analgesic consumption, duration of chest-tube drainage or postoperative recurrences. Due to the use of disposable instruments the cost was higher for a VATS approach.

Table 2. – Cost analysis of video-assisted thoracic surgery (VATS) versus open procedures

Intervention	First author [ref.]	Type of study	Total patients n	Cost of VATS
Lung biopsy	MOLIN [3]	Retro	37	Higher
Wedge excision of lung nodules	HAZELRIGG [4]	Retro	76	No difference
Pneumothorax	SUGI [5]	Retro	50	Lower
	CRISCI [6]	Retro	60	Lower
	KIM [7]	Pro	66	Higher
	HYLAND [8]	Retro	50	No difference but lower socioeconomic cost
LVRS	KO [9]	Retro	42	Lower
Lung cancer	SUGI [5]	Retro	30	Higher
	NAKAJIMA [10]	Retro	102	Lower

Pro: prospective; Retro: retrospective; LVRS: lung volume reduction surgery.

In a recent retrospective case series, cost was analysed in 50 patients with spontaneous pneumothorax; 22 treated by VATS and 28 by a limited axillary thoracotomy [8]. There was no difference in operating time, but the length of stay was shorter in the VATS group. However, the overall cost of VATS was not different than that of a limited thoracotomy. This study also looked at socioeconomic cost, which was lower in the VATS group since the latter missed significantly less time from work postoperatively. This study concluded that VATS was a cost-effective and better-tolerated procedure for the treatment of spontaneous pneumothorax compared with an open technique.

### Lung volume reduction surgery

Only one study specifically compared the cost of LVRS by a bilateral VATS approach (n=23) with an open technique by sternotomy (n=19) [9]. This was a nonrandomised study in patients with bilateral heterogeneous emphysema. Preoperatively, there was no difference in lung function or oxygen dependency. There were no intraoperative complications with VATS or sternotomy. Operating time was shorter and the number of staplers used significantly lower in the sternotomy group. In contrast, the number of days on the ventilator, in intensive care and of air leakage were longer in the sternotomy group. Operative mortality was 15% in the sternotomy group and 4% in the VATS group. Hospital stay was longer in the sternotomy group (13.8 days) compared with the VATS group (9.7 days), but this difference was nonsignificant. Total inpatient cost was higher in the sternotomy group but no specific details were provided.

It is not clear how patients were selected for sternotomy or a VATS approach. Moreover, sternotomy was used early in the experience and the rather poor results in this group probably reflect the learning curve of the authors.

### Lung cancer

In the study by SUGI *et al.* [5], who also analysed wedge resection for lung nodules, 10 VATS lobectomies for lung cancer were compared with 20 open procedures. Operating time and the cost of disposables were significantly higher in the VATS group but the length of hospital stay was the same. Thus, total hospital charges were higher in the VATS lobectomy group. Again, hospital stay, which is a major cost element, was extremely long in this study, being 25.2 days for VATS lobectomy and 27.7 days for an open procedure.

In another Japanese study, the cost of VATS performed for lung cancer or lung metastases was compared with an open procedure by thoracotomy [10]. There were 79 patients with primary nonsmall cell lung cancer of which 40 had a VATS procedure. Conversely, 22 of 23 patients with lung metastases underwent resection by a VATS approach. In total, there were 72 lobectomies, but only eight were performed by using VATS. Of the 30 segmentectomies or partial lung resections, only two were performed by thoracotomy. Hospital stay was significantly longer in the thoracotomy group, 23.8 days versus 17.3 days in the VATS group, and total hospital charges were also significantly higher in the thoracotomy group. However, these were highly selected patients and major complications were excluded. The total numbers of procedures during the study period was not mentioned. Rearranging the figures, there were 36 VATS procedures of which 61% were performed for a single lung metastasis; of the 66 thoracotomies, 98.5% were for primary nonsmall cell lung

cancer. Therefore, this study is in fact a comparison between VATS resection of metastases versus lobectomy by an open procedure. Not surprisingly, the cost was higher in the latter group. The total length of hospitalisation was also very high, even in the VATS group.

## Discussion

VATS is a fascinating new approach to perform thoracic operations. Cost-containment has become a major issue today. No prospective randomised series exist specifically analysing the cost issue. In the literature search, only one prospective study was found, the others were retrospective. When analysing these critically, the different groups were not homogeneous and not all relevant factors were considered in calculation of costs. Especially in the Japanese studies, there was an excessive length of stay that seems unacceptable in the USA and Europe. The number of days of hospitalisation is a major element in total cost, thus reduction in the length of stay has a major influence on overall cost. Due to the heterogeneity of these studies, the results should be interpreted with great caution and no definite conclusions can be drawn.

Specifically in developing countries, the cost of a VATS procedure is a major concern, especially the price of endostaplers and disposable instruments [12]. In some countries the cost of one endostapler and one reloadable cartridge is twice the average annual income. Thus, cost-containing strategies are necessary. These include precise patient selection according to well-defined indications, the use and modification of conventional thoracic instruments, limited use of consumables and special trocar ports, and application of endoscopic suturing techniques [12].

From several studies it is clear that the procedure-related costs of video-assisted thoracic surgery are higher than those of a limited thoracotomy, and that a substantial patient benefit has not been clearly demonstrated. Further prospective randomised studies are necessary to clarify the cost issue more precisely. Strategies of cost reduction should be developed to make video-assisted thoracic surgery an acceptable approach in thoracic surgery that can be widely adopted, even in developing countries.

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