



# Cost reduction in video-assisted thoracoscopic lobectomy

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**Abstract:** Video-assisted thoracoscopic surgery lobectomy (VATSL) has become a cornerstone of the management of early stage non-small cell lung cancer as well as of other pulmonary diseases. While VATSL is clearly associated with reduced complications and the potential for earlier return to normal activities compared to the traditional open thoracotomy approach, there has been substantial debate over the cost-effectiveness of the procedure. We and others have hypothesized that if one could reduce the costs of VATSL by targeted interventions in the way the operation is carried out, then its cost-effectiveness could be improved—likely to the point at which it would be reproducibly more cost-effective than thoracotomy lobectomy (THORL). In this review, we discuss the recent literature on cost-effectiveness and cost-reduction strategies for VATSL, including our own work on the subject.

**Keywords:** Costs and cost analysis; cost savings; surgical instruments; thoracic neoplasms; thoracic surgery; video-assisted

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## VATSL: history and current usage

Thoracoscopy was first introduced to thoracic surgery in 1909, but it was not until the late 1980s and early 1990s that video-assisted thoracoscopic surgery (VATS) began in earnest (1). When the first large case study was published in 1993, VATS lobectomy (VATSL) was far from routine (2). Of the 1,820 patients who underwent a VATS procedure, 439 (24.1%) were eventually converted to thoracotomy, and only 38 (2.1%) underwent VATSL. Additionally, VATSL was associated with higher rates of prolonged air leak and longer operating room times compared to thoracotomy lobectomy (THORL). The authors concluded that: “*video-assisted lobectomy remains experimental with the potential for major complications.*”

Adoption of VATSL over THORL has advanced gradually over the 1990s and 2000s with the publication of a series of papers demonstrating shorter length of stay (3-9) and slightly lower complication rates (3-5,8,10-13). Further studies showed similar, if not better, oncologic

(6,14-17) and quality of life outcomes between the two procedures (18,19). Most thoracic surgeons have been convinced that VATS lobectomy is the ideal approach to lobectomy for carefully staged, clinical stage I patients, and many believe it is appropriate for patients with N1 and even N2 disease as well. Centers across the United States and the world have now become more familiar with these techniques (20). Today, guidelines from organizations including the American College of Chest Physicians recommend VATSL over THORL for clinical stage I non-small cell lung cancer (21). Submissions to this journal have called for VATSL to be declared the standard of care for early stage lung cancer (22).

## VATSL overall and in-hospital costs

With the rise of VATSL and increasing evidence of the clinical benefits of VATSL over THORL, further attention has been paid to the economic implications of this

transition. The increasing number of lung cancer patients who are covered by insurance systems which provide a fixed, global payment for an episode of care, regardless of the specific costs incurred during that episode, have made health-care providers particularly interested in the costs of pulmonary lobectomy. This is of particular interest as this is one of the most common in-patient thoracic operations performed. Given the established shorter length of stay for VATSL *vs.* THORL patients, at first glance it would appear reasonable to expect that overall hospital costs would also be decreased with adoption of VATSL.

This correlation was indeed demonstrated on a large scale by Swanson and colleagues in 2012 (23). In a retrospective cohort of 3,961 patients, compared to THORL, VATSL was associated with lower rates of adverse events ( $P=0.019$ ), shorter length of stay (7.83 *vs.* 6.15 days,  $P<0.001$ ), and lower hospital costs (\$21,016 *vs.* \$20,316,  $P=0.027$ ). The authors conclude that their study demonstrates “*strong evidence showing that VATS lobectomy for lung cancer has both clinical and economic advantages over traditional open thoracotomy for lobectomy.*”

Other studies have investigated whether VATSL is associated with lower costs after discharge. In 2014, Farjah and colleagues queried a database of 9,962 patients, finding that VATSL 90-day costs were lower than those of THORL by \$3,476 (24). However, they determined that the primary driver of these decreased VATSL costs compared to THORL was the reduced rate of prolonged length of stay (greater than 14 days) after surgery, rather than the smaller difference observed in re-admission rates or emergency department utilization after discharge. Like Swanson, Farjah found hospitalization costs to be significantly lower in VATSL than in THORL.

While these large retrospective database studies provide evidence for decreased in-hospital costs of VATSL compared to THORL, other studies have found no significant difference in hospitalization cost (6,25-27). In a particularly large dataset of 13,619 patients, Gopaldas and colleagues found no statistically significant difference in hospitalization costs for VATSL compared to THORL (25). Similarly, in their 2009 retrospective database study of 12,958 patients, Farjah and colleagues found decreased length of stay associated with VATSL, but no cost benefit (6).

Several authors have provided evidence to explain these contradictory data. In his 2016 review of VATSL costs, Brunelli discusses the population differences in various VATSL costs studies that may explain the discordance (28). It was noted early on that the surgeon may also play a part

in explaining this phenomenon. Swanson and colleagues in their 2012 database study found that surgical experience and volume significantly impacted costs (23). For VATSL, hospitalization costs for low-volume surgeons (less than 16 surgeries in a 6-month period) were nearly \$4,000 higher than those for high-volume surgeons.

### **VATSL intraoperative costs—the impact of intraoperative device use**

Other authors have focused on the higher intraoperative costs for VATSL *vs.* THORL, which has been proposed to neutralize or outweigh the cost savings that would derive from shorter length of stay with VATSL compared to THORL (23,24,27,29-31). Studies from 1993 to present have demonstrated longer operating room times for VATSL compared to THORL, with intraoperative costs making up a large portion of total VATSL hospitalization costs. For example, Deen and colleagues found that intraoperative costs were the largest category of expenses for VATSL (32). Likewise, Nakajima and colleagues found that intraoperative costs accounted for 63% of hospitalization costs for their entire cohort (29).

If thoracic surgeons, then, wish to reduce VATSL costs, the operating room is a good first place to begin. Casali and Walker, in their 2009 study, found VATSL to be less expensive overall compared to THORL (31). They found that VATSL operating room costs were nearly twice as high as those of THORL, but that this was offset by the significantly reduced hospitalization length compared to THORL. Of note, they found that intraoperative VATSL costs varied significantly by lobe and type of resection. They attribute this difference mainly to the different needs for disposable instruments such as stapler reloads. They cautioned that their findings may not be generalizable, as hospital policies and local taxes may influence the degree to which these disposables influence overall hospitalization costs.

Similar conclusions have been found in studies across the world. In the United States, Khullar and colleagues showed that intraoperative costs, and specifically stapler utilization, were a primary factor in overall hospitalization cost for VATSL at their institution (33). Importantly, they also noted that of all VATSL hospitalization costs, intraoperative and stapler costs had some of the greatest variability, and as such could be a prime target for cost reduction strategies. In Korea, Cho and colleagues found that only surgical materials were significantly more costly for VATSL than

THORL. In this study as well, these material costs varied significantly based on type of resection performed (34). These studies clearly demonstrated that intraoperative materials and devices are a significant contributor to overall VATSL hospitalization cost.

### Cost reduction strategies that thoracic surgeons can undertake

One method to control VATSL (and also THORL) costs is to attempt to reduce post-operative length of stay. In their previously discussed paper, Khullar and colleagues determined that while intraoperative costs contributed heavily to total VATSL hospitalization costs, length of stay also made up a significant portion (33). They recommend implementing standardized protocols to optimize ancillary service coordination to allow patients to return home sooner, thus reducing total costs. Other authors, too, have described clinical pathways specifically designed for thoracic surgery patients to have a more standardized and seamless transition to discharge (35-38). Pathways such as these have been investigated by groups with an eye towards their effect on overall cost (39-42). One study by Schwarzbach and colleagues directly compared VATS patients enrolled in a clinical pathway to those who were not. They found that this intervention reduced cost by 1,510 Euros per stay, with that improvement most attributable to decreased length of stay (39). Zehr and colleagues also found decreased length of stay with clinical care pathway implementation, and Wright and colleagues found a mean cost reduction of \$1,271 per patient (40,41).

While reducing post-operative length of stay by standardizing perioperative care via care pathways is an important factor in reducing VATSL hospitalization costs, surgeons are also able to personally reduce the significant cost contributed during the operation itself. As discussed in the previous section, intraoperative costs, and specifically intraoperative devices, constitute a significant portion of VATSL total hospitalization cost.

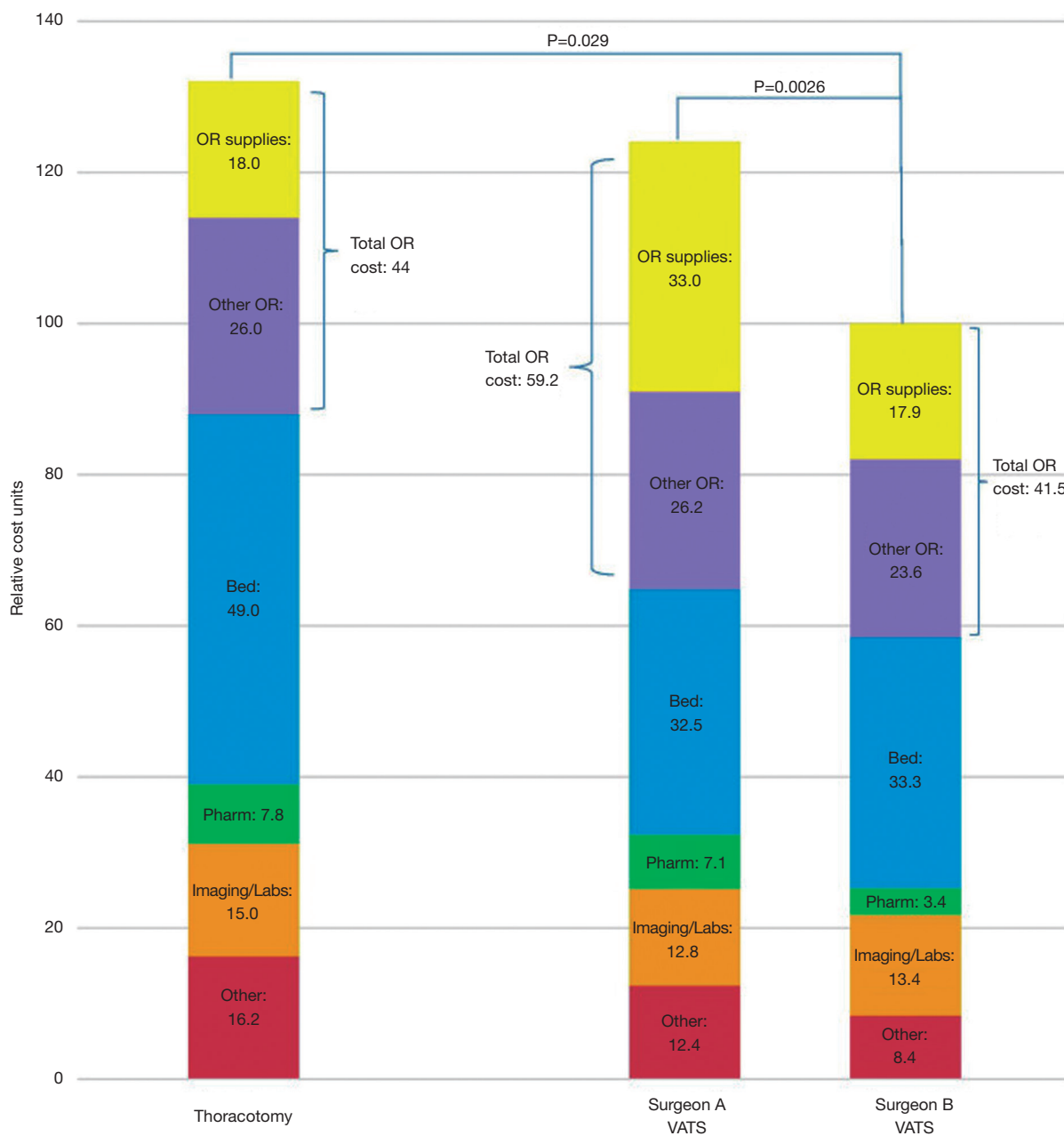
Our group recently published a study looking at costs of VATSL and THORL and the effect of intraoperative disposable instrument/device utilization on total cost (43). We found, comparing the costs incurred by two surgeons, that the increased costs of VATS lobectomy by one surgeon *vs.* those by a more cost-conscious surgeon resulted almost entirely from increased intraoperative costs (*Figure 1*). Further, the operating room cost of VATSL compared to THORL is also largely attributable to this surgeon-specific

intraoperative device utilization (*Figure 2*). Within our institution, a cost-conscious surgeon who made it a policy to avoid expensive, disposable instruments had VATSL total hospitalization costs approximately 30% lower than THORL costs, while the less cost-conscious surgeon's VATSL and THORL overall costs did not significantly differ. The overall hospital costs per case of VATSL for the more expensive surgeon were 24% higher than those for the less expensive surgeon. While the cost-conscious surgeon's stapler costs were lower than the other surgeon's, the difference in cost between the surgeons due to all other disposables (e.g., surgical sealants, energy devices, disposable ports) was more important than the effect of less staple load use. The cost-savings achieved intraoperatively during VATSL by the cost-conscious surgeon did not result in any difference in outcomes between the two surgeons.

On the basis of these results, we argue that thoracic surgeons can and should make a conscious decision to only very selectively use expensive, disposable equipment. We should not utilize expensive equipment when there is a reasonable, less expensive option which provides equal results with a similar duration of operation. We have, since publishing that paper, been working to apply a project in our institution's operating rooms to have the cost of each device placed on a label on the wrapping materials containing that device. Our plan is twofold: (I) all surgeons will go over their operating room procedure sets and selectively remove any devices that they believe they may not require; (II) during operations, when a surgeon asks for a disposable device to be opened, the circulating nurse will be instructed to read the cost of that device out loud to the surgeon—only then can the surgeon make the final decision that he or she would like the device to be opened and used.

Other authors have also recently emphasized surgeon ability to reduce intraoperative costs. In a 2018 editorial in the *Journal of Thoracic and Cardiovascular Surgery* in response to our article, D'Amico concludes that comparison of surgeon costs "*is critical if we are soon to make judgments regarding the cost-effectiveness*" of various thoracic surgical techniques (44). Demmy, in agreement, suggests that "*expensive, disposable items such as wound protectors, energy devices, and so on are not needed in every case. Staff should open these on demand only. Surgeons sharing hospital resources should discuss standardizing their setups, and hospital systems can facilitate these conversations by providing comparisons between providers and reporting costs immediately at the end of each procedure*" (45).

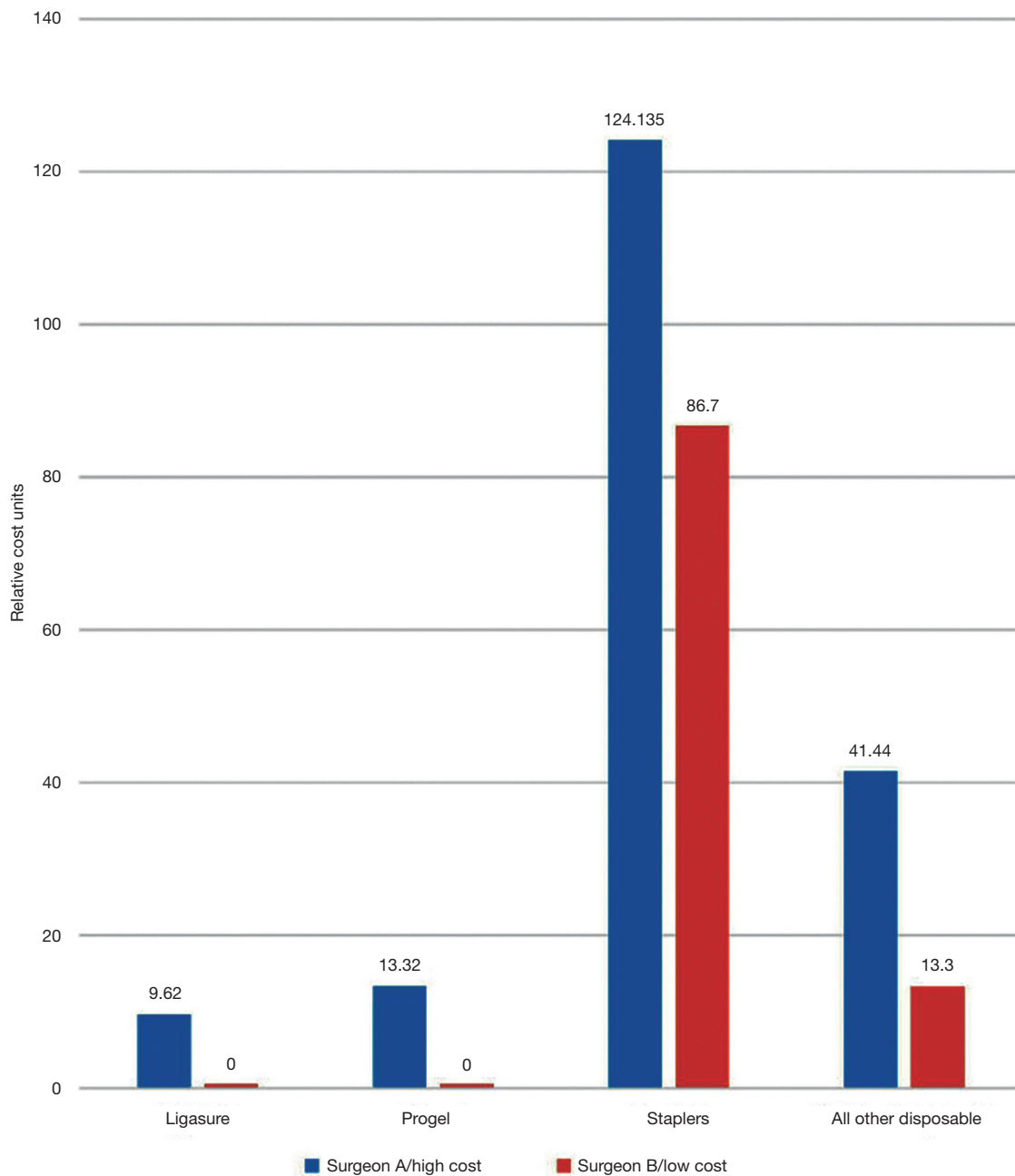
While we feel strongly that intraoperative device use can



**Figure 1** Relative hospital costs associated with VATS lobectomy by 2 surgeons, according to accounting category, compared with all open thoracotomies. The low-cost surgeon/Surgeon B’s total costs were set at a value of 100. “Other OR” consists essentially of the costs associated with OR time (reprinted from Richardson *et al.*, 2018 with permission). VATS, video-assisted thoracoscopic surgery; OR, operating room.

be judiciously reduced without increasing complications or quality of surgery, we do of course caution surgeons not to reduce expenses at the risk of undermining patient safety. Of course, utilizing fewer stapler reloads may result in lower intraoperative costs, but this is unlikely to reduce

overall costs if it leads to more cases of prolonged air leak. And it is hardly worth the savings if patient outcomes are jeopardized. Furthermore, while intraoperative costs are a major contributor to total VATSL hospitalization cost, length of stay and other postoperative care costs are of



**Figure 2** Components of intraoperative supplies costs. “All other” includes all disposables aside from those shown on other bars in this figure (reprinted from Richardson *et al.*, 2018 with permission).

course also influenced by surgical quality. Many papers point to the extreme variability of postoperative costs, which are influenced heavily by longer hospitalizations, unplanned admissions to the ICU, blood transfusions, and other issues that may be caused by surgical complications whose avoidance must be our primary endeavor (24,33,46,47).

Surgeons who have learned how to do VATS procedures using certain expensive instruments would need to gradually learn how to perform the procedures slightly differently, using less costly, alternative instruments—for example using a hook-cautery for mediastinal lymph node dissection instead of a more expensive energy device. This shift

cannot be done precipitously. Other shifts—for example from disposable to reusable ports—will be much easier to adopt. Lastly, we do not mean to imply that all newer (and thus likely expensive) intraoperative devices should be abandoned—indeed, innovation in surgery often requires large initial financial investment. Our emphasis is to point out that surgeons should consider cost-effectiveness when determining which supplies to utilize, as there is little doubt that the same operation can be done at substantially less cost, and with the same outcome, if one expends just a little bit of energy towards cost-consciousness.

### Conclusions and next steps

In an atmosphere of increasing healthcare cost scrutiny, determining the primary factors leading to hospital costs associated with a surgical procedure are of the utmost importance. For thoracic surgeons, this includes determining both the cost-effectiveness of VATSL and discussing methods to safely reduce the overall costs of the procedure.

Methods proposed to reduce costs associated with VATSL include streamlining patient care pathways and discharge processes, as unnecessary hospital days clearly add to total hospitalization costs. The most effective cost-saving role for surgeons, however, will likely be to focus on the immediate impact we can make in our operating rooms. By emphasizing hospital and system-wide efforts to enable intraoperative cost-consciousness with regard to disposable and non-essential surgical adjuncts, we can substantially reduce costs of VATSL. These include such actions as increased availability of information about the costs associated with each device to surgeons. At our institution, we have begun a process to make all surgeons aware of the cost of each disposable instrument before they commit to opening and using it, so that they have the autonomy to determine if the higher costs that would be incurred are necessary for a particular patient's case.

While the results of comparative analyses of total hospitalization costs for VATSL compared to THORL have been inconsistent, this uncertainty is largely due to the potentially high costs of intraoperative devices and adjuncts that many surgeons use to perform VATSL. With careful surgical instrumentation selection, VATSL costs can be reduced to levels well below those of THORL. With shorter length of stay for VATSL compared to THORL as well as equivalent or improved additional clinical outcomes, there is little doubt that it would be a consistently more

cost-effective procedure than THORL if we could keep the intraoperative costs within reason. These cost-reduction steps will of course also become important as we have moved into the era of comparing the costs of VATSL to robotic lobectomy.

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