

Open thoracotomy versus video-assisted thoracoscopic surgery for the treatment of spontaneous pneumothorax: which is better?

Toracotomia aberta versus cirurgia toracoscópica videoassistida para o tratamento do pneumotórax espontâneo: qual é melhor?

Marcus Vinícius Vieira Torquato¹, Târsio Thiago Lopes Alves Filho¹, Douglas Mendes Soares¹, Renan Castro Bandeira¹, Pedro Vinicius Pompeu de Oliveira¹

ABSTRACT

Introduction: Primary spontaneous pneumothorax results from the spontaneous rupture of an apical subpleural bleb, commonly seen in smokers, predominantly affecting young, thin, and tall men without underlying pulmonary diseases. In contrast, secondary spontaneous pneumothorax affects older individuals with underlying pulmonary diseases such as emphysema, asthma, infections, among others.

Objective: To compare, based on scientific evidence found in the literature, open thoracotomy and video-assisted thoracoscopic surgery in the treatment of patients with spontaneous pneumothorax.

Method: A comprehensive literature review was conducted using data obtained from the PubMed, Medline (Virtual Health Library), and Scopus databases, selecting articles published between 2019 and July 2024, in English, excluding duplicate and irrelevant studies.

Result: After identifying 79 studies, removing 13 duplicates, and completing the entire screening process, 11 relevant articles were included in this review. These articles revealed that open thoracotomy is associated with a lower recurrence rate, while video-assisted thoracoscopic surgery proved to be safer, more effective, less invasive, and provides better aesthetic outcomes.

Conclusion: Open thoracotomy and video-assisted thoracoscopic surgery are both surgical procedures used in the treatment of spontaneous pneumothorax, with the choice between them depending on the specific characteristics of each case and the particular advantages of each technique.

KEYWORDS: Pneumothorax. Thoracotomy. Thoracoscopy.

Central Message

Primary spontaneous pneumothorax results from the spontaneous rupture of an apical subpleural bleb, commonly seen in smokers, predominantly affecting young, thin, and tall men without underlying pulmonary diseases. In contrast, secondary spontaneous pneumothorax affects older individuals with underlying pulmonary diseases such as emphysema, asthma, infections, among others. This article intends to compare open and video-assisted thoracoscopic approach to treat this medical problem.

Perspective

The rationale for conducting this study lies in the importance of understanding the differences between these 2 methods, not only in terms of their clinical advantages and disadvantages but also their impact on healthcare costs, patient recovery, and the occurrence of negative outcomes such as recurrences and complications.

RESUMO

Introdução: O pneumotórax espontâneo primário resulta da ruptura espontânea de uma bolha subpleural apical, comumente observada em fumantes, acometendo predominantemente homens jovens, magros e altos, sem doenças pulmonares subjacentes. Em contraste, o pneumotórax espontâneo secundário afeta indivíduos idosos com doenças pulmonares subjacentes, como enfisema, asma, infecções, entre outras.

Objetivo: Comparar, com base em evidências científicas encontradas na literatura, a toracotomia aberta e a cirurgia videotoracoscópica no tratamento de pacientes com pneumotórax espontâneo.

Método: Foi realizada uma revisão abrangente da literatura utilizando dados obtidos nas bases de dados PubMed, Medline (Biblioteca Virtual em Saúde) e Scopus, selecionando artigos publicados entre 2019 e julho de 2024, em inglês, excluindo estudos duplicados e irrelevantes.

Resultado: Após identificar 79 estudos, remover 13 duplicatas e concluir todo o processo de triagem, 11 artigos relevantes foram incluídos nesta revisão. Esses artigos revelaram que a toracotomia aberta está associada a uma menor taxa de recorrência, enquanto a cirurgia toracoscópica videoassistida mostrou-se mais segura, mais eficaz, menos invasiva e com melhores resultados estéticos.

Conclusão: A toracotomia aberta e a cirurgia toracoscópica videoassistida são procedimentos cirúrgicos utilizados no tratamento do pneumotórax espontâneo, sendo que a escolha entre eles depende das características específicas de cada caso e das vantagens particulares de cada técnica.

PALAVRAS-CHAVE: Pneumotórax. Toracotomia. Toracosopia.

¹Ceará State University, Center of Health Sciences, Fortaleza, CE, Brazil.

Conflict of interest: None | Funding: None | Received: 12/04/2025 | Accepted: 29/04/2025 | Publication date: 20/06/2025 | Correspondence: vinicius.torquato@aluna.uece.br | Associate Editor: Nerlan Tadeu Gonçalves de Carvalho

How to cite:

Torquato MVV, Alves Filho TTL, Soares DM, Bandeira RC, de Oliveira PVP. Toracotomia aberta versus cirurgia toracoscópica videoassistida para o tratamento do pneumotórax espontâneo: qual é melhor? BioSCIENCE. 2025;83:e00015

INTRODUCTION

Pneumothorax is a medical emergency caused by the accumulation of air or gas in the pleural space between the parietal and visceral pleura, which can affect ventilation, oxygenation, or both.^{1,2} It can developed spontaneously, traumatically, or iatrogenically. Spontaneous pneumothorax is divided into primary and secondary.³

Regarding epidemiology, primary spontaneous pneumothorax affects approximately 18 to 28 men and 1.2 to 6 women per 100,000 individuals. As for secondary spontaneous pneumothorax, it is associated with the presence of pre-existing pulmonary diseases, with chronic obstructive pulmonary disease, being the main one.⁴

Primary spontaneous pneumothorax results from the spontaneous rupture of an apical subpleural bleb, commonly seen in smokers, predominantly affecting young, thin, and tall men without underlying pulmonary diseases. In contrast, secondary spontaneous pneumothorax affects older individuals with underlying pulmonary diseases such as emphysema, asthma, infections, among others.^{5,6}

The most common symptom is local pleuritic pain accompanied by dyspnea, which may have an acute onset and resolve within 24 h, even if the pneumothorax persists. Diagnosis is usually made through chest X-rays and clinical examinations. Additionally, computed tomography can be used to detect blebs or underlying pulmonary diseases.⁶

The treatment for spontaneous pneumothorax can be conservative or surgical. Conservative is carried out through needle aspiration, chest drainage, oxygen supplementation, and rest. However, the disadvantage of this method is the high possibility of pneumothorax recurrence, necessitating surgical intervention. Surgical treatment is performed via open thoracotomy or video-assisted thoracoscopic surgery (VATS), with the latter being the primary choice for the treatment of pneumothorax.^{1,6,7}

Therefore, the rationale for conducting this study lies in the importance of understanding the differences between these 2 methods, not only in terms of their clinical advantages and disadvantages but also their impact on healthcare costs, patient recovery, and the occurrence of negative outcomes such as recurrences and complications.

The objective was to analyze and compare open thoracotomy and “”, both of which are responsible for the surgical treatment of patients with spontaneous pneumothorax, based on the available evidence in the literature.

METHOD

This study is an integrative literature review, constructed from the following steps: identification

of the topic and formulation of the guiding question; establishment of article selection criteria; data collection; interpretation of results; and presentation of the review.⁸

To achieve the objective, the PICO strategy was used to formulate the guiding question, represented in Table 1. PICO is an acronym representing Patient “P”, Intervention “I”, Comparison “C”, and Outcome “O”. For this study, the following was determined: P – patients with spontaneous pneumothorax; I – thoracotomy; C – VATS; O – effectiveness, recovery time, complications, and postoperative outcomes. Thus, the guiding question was established as follows: “In the treatment of patients with spontaneous pneumothorax, how does open thoracotomy compare to video-assisted thoracoscopic surgery in terms of effectiveness, recovery time, complications, and postoperative outcomes?”

TABLE 1 — Structuring the PICO strategy

P	Patients with spontaneous pneumothorax
I	Thoracotomy
C	Video-assisted thoracoscopic surgery (VATS)
O	Effectiveness, recovery time, complications, and postoperative outcomes

The bibliographic survey was conducted using articles published in the US National Library of Medicine (PubMed), Scopus, and the Virtual Health Library, with the latter including only studies from the Medline portal. The search was carried out using terms from the Health Sciences Descriptors (DeCS/MeSH), specifically: “Pneumothorax, Spontaneous”, “Thoracotomy”, and “Video-Assisted Thoracic Surgery”. The descriptors were combined using the boolean operator “AND”.

Data identification was carried out in July 2024, and the following inclusion criteria were adopted: full-text and open-access studies, published from the year 2019 onward, written in English, and addressing the issue of thoracotomy and video-assisted thoracoscopic surgery for the treatment of patients with spontaneous pneumothorax. Additionally, duplicate articles, those with deviations from the proposed topic, and/or articles in languages other than those selected were excluded.

Based on the search strategy and inclusion criteria, 79 articles were identified. After removing 13 duplicates using the online tool EndNote, 66 studies remained for title/abstract screening. Subsequently, exclusion criteria were applied, resulting in 20 studies for full-text review. After a comprehensive evaluation of the complete texts and the exclusion of articles that did not address the topic, 7 articles were selected to compose this integrative literature review.

The article selection process followed the PRISMA flowchart⁹ recommendations and is represented in Figure.

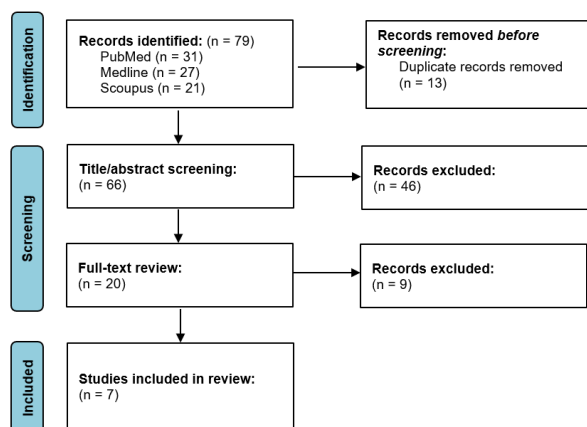


FIGURE — Flowchart of study selection from databases.

DISCUSSION

Surgical treatment for spontaneous pneumothorax is performed either through open thoracotomy or VATS, depending on the case. The conventional method is open thoracotomy, with bullectomy in patients with primary spontaneous pneumothorax, but VATS is considered safer, more effective, and less invasive.⁵

A cohort study⁵ analyzed patients who underwent surgery, including open thoracotomy and VATS, for the treatment of primary spontaneous pneumothorax. The study compared the procedures in terms of safety, effectiveness, duration of the procedure, and length of hospital stay and a brief improvement in those comparable variables was observed when analyzing the VATS technique compared to open thoracotomy.

Another study¹⁰ investigated the risk factors for recurrence of primary spontaneous pneumothorax

following VATS, highlighting a higher recurrence rate compared to open thoracotomy.

Meanwhile, another study¹¹ examined patients in terms of epidemiological characteristics, underlying diseases, treatment methods, complications, and mortality related to secondary spontaneous pneumothorax. It was found that the higher recurrence rate of spontaneous pneumothorax in patients treated with VATS compared to open thoracotomy is due to a greater likelihood of bubble errors.

A population-based study¹² analyzed additional risk factors for recurrence after VATS for primary spontaneous pneumothorax, including younger age and the use of non-steroidal anti-inflammatory drugs. Younger age and the use of anti-inflammatory drugs were identified as risk factors for recurrence and reintervention within 1 year.

Other studies^{13,14} analyzed the uniportal VATS procedure for the treatment of primary spontaneous pneumothorax. Both highlighted the advantages, such as reduced patient pain and improved respiratory function, and complications, such as prolonged air leakage following surgery, associated with the use of the VATS technique for patients affected by primary spontaneous pneumothorax.

Another study¹ compared axillary thoracotomy VATS for the treatment of patients with spontaneous pneumothorax, revealing various complications associated with each procedure. Postoperative recurrence was observed in smokers who underwent VATS, and a longer hospital stay was noted in those treated with axillary thoracotomy. The results are presented in Table 2.

TABLE 2 — Selected articles on the topic

DATABASE	TITLE	AUTHOR/ Year of Publication	OBJECTIVE	CONCLUSION
PUBMED	Comparison of VATS and limited axillary thoracotomy in the treatment of spontaneous pneumothorax: a cross-sectional study ¹ .	Hasan Oguz Kapicibasi / 2021.	Compare the results of conventional axillary mini-thoracotomy with video-assisted thoracic surgery (VATS) in the treatment of spontaneous pneumothorax.	It was found that VATS for the treatment of spontaneous pneumothorax reduces hospital stay and can be more widely utilized.
PUBMED	Primary spontaneous pneumothorax: open thoracotomy vs. video-assisted thoracoscopic surgery: A single-center retrospective cohort study ⁵ .	Mehrabi S, Shadmehr MB, Irajie C, Yavari Barhaghtalab MJ. / 2023.	Compare the outcomes of video-assisted thoracoscopic surgery and open thoracotomy in patients with secondary spontaneous pneumothorax.	Compared to open thoracotomy, video-assisted thoracoscopic surgery may be the primary treatment option for surgical management of primary spontaneous pneumothorax due to its shorter procedure duration and reduced complications, such as air leaks.
PUBMED	Risk factors for the recurrence of primary spontaneous pneumothorax after video-assisted thoracoscopic surgery in patients younger than 40 years ¹⁰ .	Shigenobu T, Ohtsuka T, Yoshizu A. / 2023.	Investigate the risk factors for postoperative recurrence of primary spontaneous pneumothorax after video-assisted thoracoscopic surgery.	An age under 20 years and a history of contralateral pneumothorax were risk factors for postoperative recurrence of pneumothorax. Reinforcement of the staple line with a PGA sheet and autologous blood spraying reduced the postoperative recurrence rate of primary spontaneous pneumothorax.
PUBMED	Morbidity, mortality, and surgical treatment of secondary spontaneous pneumothorax ¹¹ .	Mehmet. / 2023.	Assess the epidemiological characteristics, risk factors for mortality and morbidity, and treatment options for secondary spontaneous pneumothorax.	Large pneumothorax, poor physical performance, and comorbidities are associated with increased morbidity and mortality. The initial management of a small pneumothorax is typically conservative, while a large pneumothorax is managed with the placement of a chest drain. The most appropriate surgical technique for managing the bleb region is video-assisted thoracic surgery or mini-thoracotomy (mini-AT).
SCOPUS	Recurrence rate and risk factors for recurrence after thoracoscopic surgery for primary spontaneous pneumothorax: A nationwide population-based study ¹² .	Hung WT, Chen HM, Wu CH, Hsu WM, Lin JW, Chen JS. / 2021.	Determine the recurrence rate and risk factors for recurrence after video-assisted thoracoscopic surgery for primary spontaneous pneumothorax.	In Taiwan, the one-year recurrence rate was 13.7% after video-assisted thoracoscopic surgery for primary spontaneous pneumothorax. Younger age and the use of NSAIDs, particularly ketorolac, were significant risk factors for both short-term and long-term recurrence.
VHL (MEDLINE)	Unilateral single-port thoracoscopic surgery for bilateral pneumothorax or pulmonary bullae ¹³ .	Li X, Wang X, Zhang H, Cheng H, Cao Q. / 2019.	Investigate whether tubeless single-port video-assisted thoracic surgery (Tubeless-SPVATS) via the anterior mediastinum can be used as an alternative surgical treatment for bilateral lung diseases, particularly for concurrent or contralateral recurrent primary spontaneous pneumothorax.	Tubeless-SPVATS via the anterior mediastinum is a safe and viable treatment for patients with primary spontaneous pneumothorax or simultaneous bilateral pulmonary blebs. However, the contralateral thorax is not adequately explored, and when contralateral pulmonary blebs are located near the hilum, the endoscopic linear stapler may not be easily used for suturing. As a result, the recurrence rate following tubeless-SPVATS may be higher compared to open thoracotomy. Nevertheless, compared to bilateral thoracic surgery, this method reduces postoperative pain and takes significantly less time. Therefore it has some clinical value.
PUBMED	Uniportal VATS technique for primary spontaneous pneumothorax: An analysis of 46 cases ¹⁴ .	Kapicibasi HO. / 2020.	In the treatment of primary spontaneous pneumothorax, the influence of safety and applicability of the uniportal video-assisted thoracoscopic surgery method, including bullectomy/blebectomy and pleurectomy, was evaluated in 46 patients.	With the uniportal video-assisted thoracoscopic surgery technique, not only biopsy and pulmonary resection but also bullectomy/blebectomy and pleurectomy can be safely performed in the treatment of primary spontaneous pneumothorax. Given this information, minimally invasive techniques are considered more advantageous than conventional methods.

The advantage of open thoracotomy over VATS is its lower recurrence rate. One of the studies¹⁰ showed that the recurrence rate for VATS is approximately 4-11%, which is higher than the rate for open thoracotomy with bullectomy, around 1%. The higher recurrence of pneumothorax after VATS is attributed to the greater likelihood of bubble errors compared to open thoracotomy.¹¹

Additionally, open thoracotomy, although traditional, offers other advantages, such as the ability to perform more complex procedures and a reduced need for specialized equipment. VATS, on the other hand, requires greater surgical skill and advanced training.¹⁵

Younger age and the use of non-steroidal anti-inflammatory drugs are the main risk factors for pneumothorax recurrence after surgical procedures. Continuous physical growth during adolescence can alter chest dimensions, creating negative pressure and causing the formation of subpleural blebs. Meanwhile, anti-inflammatory drugs can affect the quality of pleurodesis by inhibiting the inflammatory response.¹² The risk of pneumothorax recurrence after surgical pleurodesis ranges from 0% to 4%.¹⁶

Pleurodesis is an effective method for preventing the recurrence of pneumothorax, aiming to eliminate the virtual space between the visceral and parietal pleurae. Among the available options, talc is widely used due to its proven efficacy, with success rates ranging from 87% to 100%.^{17,18}

The VATS procedure can be performed using various approaches, including three-port, two-port, and uniportal techniques.¹ Currently, the uniportal technique is widely used by surgeons due to its ability to achieve better cosmetic results compared to open thoracotomy, owing to a smaller incision typically located in the fifth or sixth intercostal space in the axillary regio.^{13,14}

Open thoracotomy can cause neuropathic pain during the postoperative period. This pain can become chronic and is characterized by burning sensations, numbness or paresthesia, pressure sensation, and tenderness.¹ Meanwhile, the most common complication in VATS is prolonged air leakage, which requires postoperative drainage for a period of 2-7 days.^{1,14}

Regarding the duration of surgery and hospital stay, VATS has a shorter duration compared to open thoracotomy. However, the length of hospital stay did not show a significant difference between the 2 interventions.⁵

The costs associated with each technique are complex and depend on various factors, such as surgical time, the need for specialized equipment, and the length of hospital stay. Although VATS require a higher initial investment in equipment, it may be more cost-effective in the long run due to lower complication rates, and shorter hospital stays.¹⁹

CONCLUSION

Surgical treatment of patients with spontaneous pneumothorax can be performed either through open thoracotomy or VATS, depending on the specific case. The advantage of open thoracotomy is the lower chance of pneumothorax recurrence after the intervention, while VATS offers a shorter procedure duration, reduced hospital stay, and better cosmetic results, making it safer, more effective, and less invasive. Additionally, the limited number of studies available to compose this literature review, due to these being alternative treatment techniques still under evaluation, was the main limitation of this work. However, the findings of this study may contribute to the implementation of these procedures in medical practice and the treatment of various patients.

Author's contribution

Marcus Vinicius Vieira Torquato: Conceptualization

Társio Thiago Lopes Alves Filho: Formal analysis

Douglas Mendes Soares: Methodology

Renan Castro Bandeira: Project administration

Marcus Vinicius Vieira Torquato: Writing, Original draft preparation

Marcus Vinicius Vieira Torquato, Társio Thiago Lopes Alves Filho Writing: Review & editing

REFERENCES

1. Kopicibasi HO. Comparison of VATS and limited axillary thoracotomy in the treatment of spontaneous pneumothorax: a cross-sectional study. *J Pak Med Assoc.* 2021;71(4):1107–12. doi: https://www.ojs.jpma.org.pk/index.php/public_html/article/view/612
2. Charisma AN, Bakhtiar A. Wedge resection on recurrent pneumothorax, failed lung expansion after needle aspiration: a case report. *Int J Surg Case Rep.* 2021;83:106000. doi: <https://doi.org/10.1016/j.ijscr.2021.106000>
3. Vayvada M, Tezel Y, Tezel Ç. Is it a myth to perform blind apical wedge resection in primary spontaneous pneumothorax surgery to improve recurrence rates? *J Minim Access Surg.* 2022;18(2):279–83. doi: https://doi.org/10.4103/jmas.jmas_269_20
4. Mundim Filho MT, de Oliveira TR, Araujo JVG, De Oliveira TR, Pereira DA, Pinto e Plantino B, et al. Pneumotórax espontâneo - novas perspectivas sobre avaliação diagnóstica e uso de cirurgia minimamente invasiva para manejo do paciente. *Braz J Dev.* 2022;8(10):69898–909. doi: <https://doi.org/10.34117/bjdv8n10-327>
5. Mehrabi S, Shadmehr MB, Irajie C, Yavari Barhaghtalab MJ. Primary spontaneous pneumothorax: open thoracotomy vs. video-assisted thoracoscopic surgery: a single-center retrospective cohort study. *Iran J Med Sci.* 2023;48(1):49–56. doi: <https://doi.org/10.30476/ijms.2022.91422.2260>
6. Cakmak M, Durkan A. Analysis of patients undergoing surgical treatment for primary spontaneous pneumothorax. *Niger J Clin Pract.* 2021;24(11):1669–73. doi: https://doi.org/10.4103/njcp.njcp_361_20
7. Steenwijk van, Spaans LN, Heineman DJ, Frank, Dickhoff C. Population-based study on surgical care for primary spontaneous pneumothorax. *Eur J Cardiothorac Surg.* 2024;65(4). doi: <https://doi.org/10.1093/ejcts/ezae104>
8. Fernando S, Campos. Complicações com o uso do cateter totalmente implantável em pacientes oncológicos: revisão integrativa. *Cogitare Enferm.* 2009;14(1):159–64.
9. PRISMA statement. [Prisma-statement.org](https://www.prismastatement.org/s/PRISMA_2020_flow_diagram_new_SRs_v1-lml8.docx); 2024. doi: https://www.prismastatement.org/s/PRISMA_2020_flow_diagram_new_SRs_v1-lml8.docx
10. Shigenobu T, Ohtsuka T, Yoshizu A. Risk factors for the recurrence of primary spontaneous pneumothorax after video-assisted thoracoscopic surgery in patients younger than 40 years. *J Thorac Dis.* 2023;15(7):3783–90. doi: <https://doi.org/10.21037/jtd-23-257>
11. Değirmenci M. Morbidity, mortality, and surgical treatment of secondary spontaneous pneumothorax. *Ulus Travma Acil Cerrahi Derg.* 2023;29(8):909–19. doi: <https://doi.org/10.14744/tjtes.2023.20566>

-
12. Hung WT, Chen HM, Wu CH, Hsu WM, Lin JW, Chen JS. Recurrence rate and risk factors for recurrence after thoroscopic surgery for primary spontaneous pneumothorax: a nationwide population-based study. *J Formos Med Assoc.* 2021;120(10):1890–6. doi: <https://doi.org/10.1016/j.jfma.2020.12.011>
 13. Li X, Wang X, Zhang H, Cheng H, Cao Q. Unilateral single-port thoroscopic surgery for bilateral pneumothorax or pulmonary bullae. *J Cardiothorac Surg.* 2019;14(1):71. doi: <https://doi.org/10.1186/s13019-019-0894-y>
 14. Kopicibasi HO. Uniportal VATS technique for primary spontaneous pneumothorax: an analysis of 46 cases. *Pak J Med Sci.* 2019;36(2):224–8. doi: <https://doi.org/10.12669/pjms.36.2.1556>
 15. Estevão HM, Leite IF, Siqueira ALLG, Santos TR, Ramalho JPG, Santos JS, et al. Comparative study of video-assisted thoracic surgery (VATS) and open thoracotomy: an analysis using propensity score matching. *Res Soc Dev.* 2022;11(15):e422111537521. doi: <https://rsdjournal.org/index.php/rsd/article/view/37521>
 16. Carvalho P, Romariz I, Miranda J, António J, Rodrigues. Um caso de pneumotórax espontâneo recorrente. *Rev Port Pneumol.*
 17. Sahn SA, Heffner JE. Spontaneous pneumothorax. *N Engl J Med.* 2000;342(12):868–74. doi: <https://doi.org/10.1056/NEJM200003233421207>
 18. Maskell NA, Lee YC, Gleeson FV, Hedley EL, Pengelly G, Davies RJ. Randomized trials describing lung inflammation after pleurodesis with talc of varying particle size. *Am J Respir Crit Care Med.* 2004;170(4):377–82. doi: <https://doi.org/10.1164/rccm.200311-1579oc>
 19. Chen D, Kang P, Tao S, Li Q, Wang R, Tan Q. Cost-effectiveness evaluation of robotic-assisted thoracoscopic surgery versus open thoracotomy and video-assisted thoracoscopic surgery for operable non-small cell lung cancer. *Lung Cancer.* 2021;153:99–107. doi: [10.1016/j.lungcan.2020.12.033](https://doi.org/10.1016/j.lungcan.2020.12.033)