

ARTICLE INFORMATION

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Impact of video-assisted thoracic surgery versus open thoracotomy on postoperative wound infections in lung cancer patients: A systematic review

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Abstract

Background: Lung cancer remains a leading cause of cancer-related mortality worldwide, with surgical resection being the primary curative approach for early-stage non-small cell lung cancer. Postoperative wound infections following thoracic surgery significantly impact patient outcomes, healthcare resources, and quality of life.

Purpose: To evaluate the incidence, risk factors, management, and outcomes of postoperative wound infections comparing Video-Assisted Thoracic Surgery (VATS) versus open thoracotomy in lung cancer patients.

Method: A systematic review with article selection guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The systematic review process begins with the formulation of clinical questions relevant to the topic. Before this, the authors establish PICOS criteria, which stand for: P (problem, patient, or population), I (intervention, prognostic factor, or exposure), C (comparison or control), O (outcome), and S (study design). For this article, P: Adult patients with diagnosed lung cancer who underwent surgical resection, I: Video-Assisted Thoracic Surgery (VATS), C: Open thoracotomy, O: Incidence of postoperative wound infections, infection severity, causative microorganisms, time to infection development, treatment approaches, and impact on hospital stay, S: Randomized controlled trials. The article search was conducted systematically using the keywords: "Video-Assisted Thoracic Surgery," AND "VATS," AND "Open Thoracotomy," AND "Lung Cancer," AND "Pulmonary Carcinoma," AND "Surgical Site Infection," AND "Wound Infection," AND "Postoperative Complications," AND "Surgical Wound Dehiscence," AND "Surgical Outcomes," AND "Minimally Invasive Surgery".

Results: The analysis showed that VATS had lower overall complication rates, reduced mortality, and shorter hospital stays compared to open thoracotomy, especially in high-risk patients like those with obesity. VATS conversion to thoracotomy significantly increased complications and mortality. Robot-assisted thoracic surgery offered additional benefits, including less blood loss and lower conversion rates than conventional VATS.

Conclusion: VATS is preferred over open thoracotomy for lung cancer due to lower complications, mortality, and shorter hospital stays. Conversion to thoracotomy increases risks. Robotic surgery offers additional benefits but at higher costs. Overall, minimally invasive approaches reduce wound-related complications.

Keywords: Lung Cancer; Open Thoracotomy; Postoperative Wound Infections; Video-Assisted Thoracic Surgery (VATS).

INTRODUCTION

Lung cancer remains one of the most prevalent malignancies worldwide, accounting for approximately 2.2 million new cases and 1.8 million deaths globally in 2020. Lung cancer is a leading

global malignancy, with surgical resection, particularly lobectomy, being the standard treatment for early-stage non-small cell lung cancer (NSCLC). While open thoracotomy was traditionally used,

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video-assisted thoracic surgery (VATS) has become a widely adopted minimally invasive alternative. However, postoperative complications, especially surgical site infections, continue to pose significant challenges for patient outcomes and healthcare systems (Sung, Ferlay, Siegel, Laversanne, Soerjomataram, Jemal, & Bray, 2021).

Lung cancer leading global malignancy, with surgery especially lobectomy being the main treatment for early-stage NSCLC. While open thoracotomy has been the traditional approach, minimally invasive VATS has become increasingly popular. Despite advances, postoperative complications like surgical site infections still pose significant challenges for patient outcomes and healthcare (Steen, Sorensen, Christensen, Petersen, Naidu, Bendixen & Christensen, 2023).

VATS offers advantages over open thoracotomy such as less pain, shorter hospital stay, and smaller incisions that reduce tissue trauma and infection risk. However, longer operative times and technical complexity during the learning curve may increase infection risk and affect surgical outcomes. (Basu, Goswami, David, & Mudge, 2024). Recent advances like Enhanced Recovery After Surgery (ERAS) protocols have improved postoperative outcomes in thoracic surgery by reducing complications, including wound infections. However, the specific impact of surgical approach (VATS vs. open thoracotomy) within these protocols is still unclear. Additionally, COVID-19 has affected surgical practices and may have influenced infection rates and choice of surgery. (Al-jabir, Kerwan, Nicola, Alsafi, Khan, Sohrabi, & Agha, 2020).

Studies comparing VATS and open thoracotomy focus on cancer outcomes and complications, but wound infections have been less studied and results are mixed. One large retrospective study found significantly fewer surgical site infections with VATS than with open thoracotomy (1.8% vs. 4.5%). (Aeschbacher, Nguyen, Dorn, Kocher, & Lutz, 2021). Key challenges in interpreting the evidence include inconsistent definitions and reporting of surgical site infections (SSIs), varied antibiotic use, differing follow-up methods, selection bias, and lack of standardization in VATS techniques. Advances like robotic-assisted surgery add further complexity to comparisons. (Zhou, Ren, Gao, & Zhou, 2023).

RESEARCH METHOD

A systematic review with article selection guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The systematic review process begins with the formulation of clinical questions relevant to the topic. Before this, the authors establish PICOS criteria, which stand for: P (problem, patient, or population), I (intervention, prognostic factor, or exposure), C (comparison or control), O (outcome), and S (study design). For this article, P: Adult patients with diagnosed lung cancer who underwent surgical resection, I: Video-Assisted Thoracic Surgery (VATS), C: Open thoracotomy, O: Incidence of postoperative wound infections, infection severity, causative microorganisms, time to infection development, treatment approaches, and impact on hospital stay, S: Randomized controlled trials.

The article search was conducted systematically using the keywords: "Video-Assisted Thoracic Surgery," AND "VATS," AND "Open Thoracotomy," AND "Lung Cancer," AND "Pulmonary Carcinoma," AND "Surgical Site Infection," AND "Wound Infection," AND "Postoperative Complications," AND "Surgical Wound Dehiscence," AND "Surgical Outcomes," AND "Minimally Invasive Surgery."

The inclusion criteria inquired the selected articles were in the from randomized controlled trials, prospective and retrospective cohort studies, case-control studies, and systematic reviews, studies published in English and publication period Januari 2020 – February 2025. The exclusion criteria included single case reports or small case series ($n < 10$), animal or in vitro studies, conference abstracts without full-text availability, studies focusing solely on other thoracic conditions (non-malignant), studies not reporting wound infection outcomes separately from other complications.

The initial search resulted in 67 from Pubmed, 59 from Scopus, 78 from Web of Science, 56 from EMBASE and 49 from Cochrane Library. After screening and filtering based on the predefined criteria, 10 articles met the inclusion criteria and were selected for further analysis.

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RESEARCH RESULTS

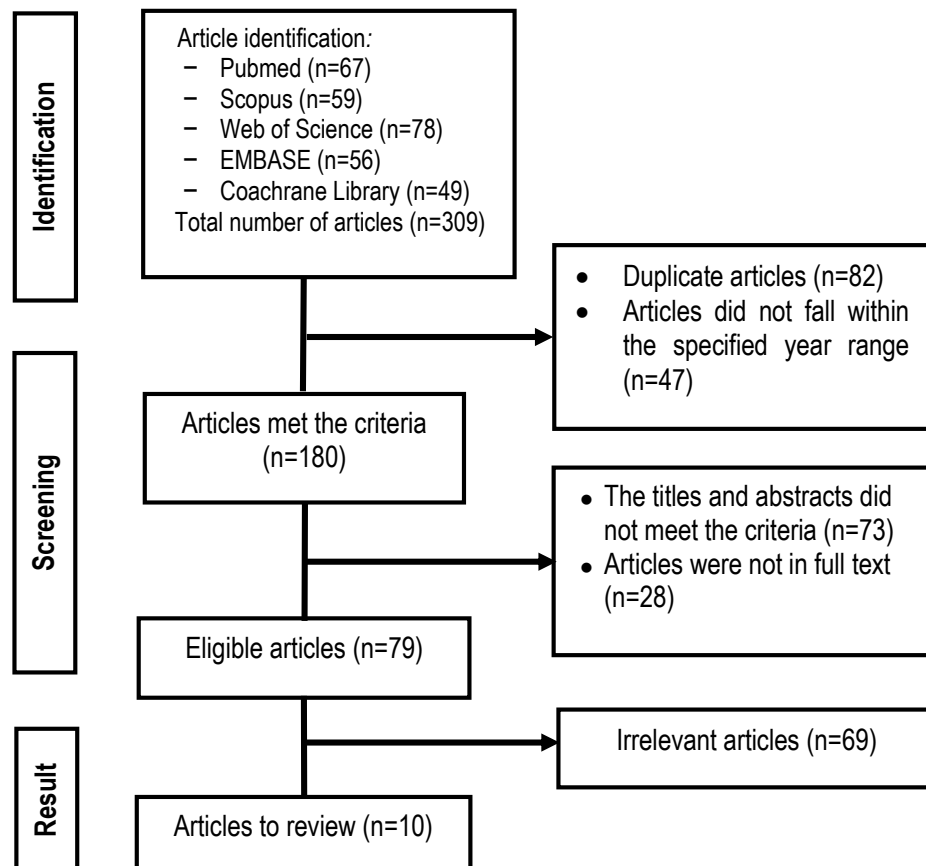


Figure PRISMA Flow Diagram

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Table Main Characteristics of Included Studies

(Author, Year)(Country)	Purpose	Methods	Results
(Seitlinger et al., 2021) (French)	To analyze the specific outcomes of patients undergoing conversion to thoracotomy despite initially scheduled Video-Assisted Thoracic Surgery (VATS) lung resection	We retrospectively reviewed 501 patients who underwent thoracoscopic anatomic lung resection (i.e. lobectomy, segmentectomy or bilobectomy) between 1 January 2012 and 1 August 2017 at our institution. We explored the risk factors for surgical conversion and adverse events occurring in patients who underwent conversion to thoracotomy.	Through the years, the global conversion rate has dramatically decreased to <10%. Nevertheless, patients who undergo conversion represent a high-risk population in terms of complications (40.9% vs 16.8%) and perioperative mortality (6.8% vs 0.2%).
(Zhang et al., 2021) (China)	To compare the safety and efficacy of Non-Intubate Video-Assisted Thoracic Surgery (NIVATS) with intubated VATS	This study included randomized controlled trials (RCTs) published up to August 2020, selected from major databases based on specific inclusion criteria. Two reviewers independently screened and extracted relevant data. After evaluating the risk of bias, a meta-analysis was conducted using Review Manager 5.3 with a random-effects model to analyze the pooled data.	NIVATS is a safe and feasible form of intervention that can reduce the postoperative pain and complications of various systems and shorten hospital stay duration without prolonging the operation time.
(Alocca et al., 2024) (Italy)	To demonstrate the safety and diagnostic yield of medical pleuroscopy under balanced analgosedation compared to VATS for pleural effusion diagnosis	This retrospective study compared Medical Thoracoscopy (MP) and Video-Assisted Thoracic Surgery (VATS) in adult patients with unexplained pleural effusion at two hospitals in Italy. Patients received either MP with local anesthesia and non-intubated propofol sedation or VATS with intubation and mechanical ventilation. The study evaluated diagnostic success, complications, procedure time, hospital stay, propofol dosage, and patient comfort.	This real-life study shows that the MP performed under propofol-based analgosedation by an independent pneumologist team is a safe and well-tolerated procedure with a diagnostic yield and complication rates similar to those obtained with VATS.

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(Author, Year)(Country)	Purpose	Methods	Results
(Ochi et al., 2023) (Japan)	To compare perioperative outcomes of VATS and Robotic-Assisted Thoracic Surgery (RATS) for mediastinal surgery	This study included 144 patients who underwent VATS and 46 who underwent RATS mediastinal surgery from 2014 to 2022. We compared clinicopathological factors such as age, sex, smoking history, respiratory function, surgical details, surgeon certification, and histology between the groups. Perioperative outcomes reviewed included operation time, blood loss, conversion to open surgery, chest drainage duration, hospital stay, and postoperative complications.	RATS for mediastinal surgery is as safe as the VATS approach and may result in a shorter operative time and postoperative hospital stay. Further analysis of RATS for mediastinal surgery in a larger cohort is warranted.
(Ma et al., 2021) (China)	To compare short-term and long-term efficacy between RATS and VATS for Non-Small Cell Lung Cancer (NSCLC)	Pubmed, Cochrane Library, Embase, China National Knowledge Infrastructure (CNKI), Medline, and Web of Science databases were comprehensively searched for studies published before December 2020. The quality of the articles was evaluated using the Newcastle-Ottawa Scale (NOS) and the data analyzed using the Review Manager 5.3 software. Fixed or random effect models were applied according to heterogeneity. Subgroup analysis and sensitivity analysis were conducted.	The results revealed that RATS is a feasible and safe technique compared with VATS in terms of short-term and long-term outcomes. Moreover, more randomized controlled trials comparing the two techniques with rigorous study designs are still essential to evaluate the value of robotic surgery for NSCLC.
(Manolache et al., 2022) (Romania)	To present essential information about VATS including classification, indications, contraindications, instruments, and training aspects	Descriptive review article	VATS is an established approach for thoracic pathologies. Either if it is multiport or uniportal, experienced surgeons in open thoracic surgery can have a smooth transition to minimally invasive surgery if given the proper instruments and training. Starting

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			every case by a minimally invasive - video assisted approach contributes to the consistency of the training even though increases the rate of conversion in the beginning.
(Guerrera et al., 2023) (Italy)	To assess morbidity and postoperative length of hospital stay in obese patients undergoing VATS vs open pulmonary lobectomy for NSCLC	We collected all consecutive patients from 2007 to 2021 submitted to lobectomy through VATS or thoracotomy with a body mass index greater than or equal to 30. An intention-to-treat analysis was carried out. Primary outcomes were morbidity rate, mortality and postoperative length of stay (LOS). Differences in outcomes were assessed through univariable, multivariable-adjusted and propensity score-matched analysis.	In obese patients with NSCLC, VATS lobectomy was associated with improved postoperative outcomes compared to open lobectomy and should be considered the approach of choice for obese populations
(Chritensen et al., 2022) (Denmark)	To determine the difference in outcome between VATS surgery vs thoracic ultrasound-guided drainage with intrapleural therapy as first-line treatment for pleural empyema	multicentre randomised, controlled study. Totally, 184 patients with a newly diagnosed community acquired complicated parapneumonic effusion or pleural empyema are randomised to either (1) VATS procedure with drainage or (2) TUS-guided pigtail catheter placement and intrapleural therapy with Actilyse and DNase. The total follow-up period is 12 months. The primary endpoint is length of hospital stay and secondary endpoints include for example, mortality, need for additional interventions, consumption of analgesia and quality of life.	In summary, this national, multicentre, randomised, controlled trial will investigate whether antibiotics and early goal directed VATS as first-line treatment should be considered the standard regimen of patients with complicated parapneumonic effusion and pleural empyema. It will hopefully benefit the initial management and treatment of this patient population making the treatment based on evidence instead of local preferences.

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(Author, Year)(Country)	Purpose	Methods	Results
(Miyajama et al., 2022) (Japan)	To compare perioperative factors and postoperative results between RATS and VATS in lung cancer patients	We reviewed records of 411 primary lung cancer patients who had lobectomy with lymph node dissection from 2017 to 2020 (103 RATS, 308 VATS). Perioperative factors and outcomes were compared. Propensity score matching (PSM) was used to reduce selection bias, matching 100 patients per group. This study uniquely included interlobar fissure completeness in the matching, a key factor affecting surgical difficulty and duration often overlooked in prior research.	Initial experience of RATS had no obvious drawbacks when compared with that of VATS on propensity-matched analysis.
(Wang et al., 2025) (China)	To evaluate the impact of thoroscopic versus open thoracotomy procedures on postoperative wound infections in lung cancer patients.	A comprehensive literature search was conducted on September 19, 2023, following PRISMA guidelines, across major databases without time or language limits. Eligible studies included peer-reviewed RCTs, cohort, and case-control studies on postoperative wound infections, while studies with irrelevant populations or lacking surgical technique comparisons were excluded. Data extraction and quality assessment were performed independently by two reviewers, and a fixed-effect meta-analysis was used due to no significant heterogeneity ($I^2 = 0.0\%$, $P = 0.766$).	The findings suggest that VATS is associated with a lower risk of postoperative wound infections compared to open thoracotomy, which has implications for surgical decision-making in lung cancer treatment.

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DISCUSSION

Video-assisted thoracic surgery (VATS) shows significantly lower complication rates than thoracotomy in obese patients (23.2% vs. 30.2%, $p < 0.001$), including severely and morbidly obese groups. However, VATS conversion to thoracotomy occurs in about 8.8% of cases, mainly due to anatomical or tumor-related issues, leading to higher complication rates (40.9% vs. 16.8%, $p = 0.001$) and mortality (6.8% vs. 0.2%, $p = 0.003$) (Lampridis, Maraschi, Le Reun, Routledge, & Bille, 2023).

Robot-assisted thoracic surgery (RATS) shows a significantly lower conversion rate than VATS (OR = 0.50, 95% CI 0.43–0.60, $p < 0.001$), indicating it may overcome some technical limits of VATS. However, complication rates between RATS and VATS are similar (10.0% vs. 13.0%, $p = 0.66$). Non-intubated VATS (NIVATS) has lower overall complication rates compared to intubated VATS (OR 0.41, 95% CI 0.25–0.67, $p = 0.0004$), suggesting ventilation method influences perioperative risk (Zhang, Alzul, Carelli, Melfi, Tian, & Cao, 2022).

Video-assisted thoracic surgery (VATS) has become a preferred minimally invasive technique for lung cancer surgery, especially in obese patients, due to its association with lower complication rates compared to traditional thoracotomy. However, the risk of conversion from VATS to thoracotomy often triggered by anatomical challenges or tumor complexity significantly increases postoperative complications and mortality. Robot-assisted thoracic surgery (RATS) offers a technological advancement that reduces conversion rates, potentially overcoming some limitations of conventional VATS, though overall complication rates remain comparable between the two methods. Additionally, the choice of ventilation strategy during VATS, such as non-intubated VATS (NIVATS), appears to further decrease perioperative risks, highlighting the impact of anesthesia management on surgical outcomes. This evidence underscores the evolving role of surgical innovation and patient-specific factors in optimizing thoracic surgery outcomes (Wu, Zhao, Zhang, Jiang, Feng, Qin, & Lin, 2023).

Non-intubated VATS with spontaneous ventilation significantly reduced hospital stay by 1.41 days (MD -1.41, 95% CI -2.47 to -0.34, $p = 0.01$) and lowered pain scores (MD -0.34, 95% CI -0.58 to -

0.10, $p = 0.006$) compared to intubated VATS. Medical pleuroscopy under pulmonologist-managed sedation had similar diagnostic yield (97.8% vs. 100%, $p = 0.374$) but used much less propofol (65.6 ± 35.8 mg vs. 280 ± 20.0 mg, $p < 0.001$) and achieved better pain control (VAS 0.34 ± 0.65 vs. 2.58 ± 1.26 , $p < 0.001$) than VATS under anesthesiologist sedation with mechanical ventilation (Khalaf, Ghoneim, Mahmoud, & Abdelwahab, 2023).

Technical efficiency between RATS and VATS varies: one study showed shorter operation times for RATS (88 min vs. 120 min, $p = 0.03$), while another found longer times for RATS (132.4 ± 37.3 min vs. 122.4 ± 27.7 min, $p = 0.001$). Lymph node assessment results are also inconsistent, with VATS showing more dissected stations in one study (5.9 ± 1.5 vs. 4.8 ± 2.2 , $p = 0.001$), but RATS having more harvested lymph nodes and stations in a meta-analysis (WMD = 1.72, $p = 0.002$; WMD = 0.51, $p = 0.005$). These discrepancies suggest the need for standardized protocols and consideration of surgeon experience (Jindal, Nar, Mishra, Singh, Aggarwal, & Bansal, 2021).

Minimally invasive thoracic surgery techniques, such as non-intubated VATS and robotic-assisted thoracic surgery (RATS), are evolving to improve patient outcomes by reducing hospital stay, pain, and anesthetic exposure while maintaining or enhancing diagnostic accuracy and surgical efficacy. Non-intubated VATS with spontaneous ventilation has demonstrated benefits in faster recovery and better pain control compared to traditional intubated VATS, highlighting the advantages of less invasive anesthesia management. Meanwhile, the comparison between RATS and VATS reveals variability in operative times and lymph node assessment, reflecting differences in surgical technique, technology, and surgeon expertise. These findings underscore the importance of standardized protocols and training to optimize the balance between procedural efficiency and oncologic thoroughness in thoracic surgery (Ayad, 2024).

Minimally invasive surgery, especially VATS, shows lower mortality (0.8% vs. 1.5%) and shorter hospital stays (median 5 vs. 7 days) compared to open thoracotomy in obese patients. RATS offers benefits over VATS, including shorter chest tube

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duration (-0.61 days), shorter hospital stay (-1.12 days), and lower recurrence rates (OR 0.51), though survival rates are similar. RATS also results in less blood loss (about 53 mL vs. 120 mL), likely due to better visualization and precision (Zhang, Yang, Liu, & Liu, 2021).

This summary highlights that VATS generally offers better outcomes than traditional thoracotomy for pleural empyema and thoracic surgery. A randomized trial is ongoing comparing VATS with ultrasound-guided drainage plus fibrinolytics, focusing on hospital stay and other outcomes. However, RATS incurs significantly higher costs about USD 3,910 more than VATS while providing only modest clinical benefits. Therefore, surgical approach decisions should consider patient factors, surgeon experience, resources, and cost-effectiveness (Salvador, Nobrega, Almeida, Torres, Camarotti, Passos, & Mariani, 2025).

RATS, as an evolution of minimally invasive surgery, provides enhanced visualization and surgical precision through robotic technology, resulting in reduced blood loss, shorter chest tube duration, and lower recurrence rates. However, despite these clinical advantages, the substantially higher costs associated with RATS necessitate careful consideration of cost-effectiveness, patient-specific factors, and surgeon expertise when selecting the optimal surgical approach (Spiezia, Liew, Campello, Gregorio, Zuin, & Simioni, 2020).

CONCLUSION

VATS is preferred over open thoracotomy for lung cancer due to lower complications, mortality, and shorter hospital stays. Conversion to thoracotomy increases risks. Robotic surgery offers additional benefits but at higher costs. Overall, minimally invasive approaches reduce wound-related complications.

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