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Current perioperative anesthetic practice in thoracic surgery: a multicenter survey from high-volume centers in Southern Italy

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Abstract

Enhanced Recovery After Surgery (ERAS) pathways have substantially changed perioperative management in thoracic surgery by promoting evidence-based interventions throughout the surgical pathway. Nevertheless, the implementation of these recommendations remains heterogeneous across institutions, and real-world data describing contemporary anesthetic practice are limited. This study aimed to characterize current perioperative anesthetic management in thoracic surgery across major referral centers in Southern Italy. A multicenter cross-sectional survey was conducted among consultant anesthesiologists routinely involved in thoracic surgery across seven hospitals in the Campania Region, Italy. An anonymous web-based questionnaire explored perioperative management, including preoperative assessment, anesthetic techniques, one-lung ventilation (OLV) strategies, regional analgesia, and postoperative care pathways. Descriptive statistics were used to summarize current clinical practice. Forty anesthesiologists completed the survey. Most respondents (92.5%) practiced in tertiary referral centers, and 84.6% worked in hospitals performing more than 150 thoracic procedures annually. Balanced volatile anesthesia and total intravenous anesthesia (TIVA) were adopted with similar frequency. Lung-protective ventilation during OLV was universally applied, with individualized positive end-expiratory pressure (PEEP) used by most participants. Ultrasound-guided regional anesthesia was incorporated into routine practice by all respondents. Conversely, considerable variability persisted regarding postoperative organizational pathways, particularly the availability of structured respiratory physiotherapy protocols and intermediate-care facilities. Evidence-based intraoperative anesthetic strategies are now widely implemented across high-volume thoracic surgery centers in Southern Italy. In contrast, postoperative organizational pathways remain heterogeneous, suggesting that future quality-improvement initiatives should primarily focus on multidisciplinary implementation of ERAS recommendations and standardization of postoperative care.

Key words: thoracic anesthesia; one-lung ventilation; regional anesthesia; ERAS; perioperative medicine; thoracic surgery; survey.

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Introduction

Thoracic surgery remains one of the most challenging fields of perioperative medicine. Despite substantial advances in minimally invasive approaches, including video-assisted thoracoscopic surgery and robot-assisted thoracic surgery, patients continue to experience considerable physiological stress related to one-lung ventilation (OLV), postoperative pain, and the high prevalence of cardiopulmonary comorbidities. These factors contribute significantly to postoperative pulmonary complications (PPCs), prolonged hospital stay, and delayed functional recovery, making perioperative management a key determinant of surgical outcomes.[1-5]

Over the past decade, perioperative care has progressively shifted from a procedure-oriented approach toward comprehensive multidisciplinary management encompassing the entire surgical pathway. Enhanced Recovery After Surgery (ERAS) programs have become the cornerstone of this paradigm by integrating evidence-based interventions before, during, and after surgery. Current ERAS and European Society of Thoracic Surgeons recommendations advocate preoperative optimization, lung-protective ventilation, multimodal opioid-sparing analgesia, early extubation, prompt mobilization, and structured respiratory rehabilitation as fundamental components of perioperative care following lung resection.[1-3] These interventions have consistently been associated with reduced postoperative morbidity, lower rates of PPCs, shorter hospital stays, and faster recovery.[1,5-7]

Within this evolving framework, the anesthesiologist has

assumed a central role extending well beyond intraoperative anesthesia. Contemporary thoracic anesthesia encompasses preoperative risk assessment, participation in prehabilitation pathways, individualized ventilatory management during OLV, ultrasound-guided regional anesthesia, postoperative analgesia, and coordination of multidisciplinary recovery protocols. In particular, protective mechanical ventilation and regional analgesia have emerged as key elements of modern thoracic anesthesia, reflecting the growing emphasis on personalized perioperative care.[2,8-13]

Recent evidence has further reinforced the concept that intraoperative ventilation should be individualized according to patient physiology rather than based on fixed ventilatory settings. The multicenter "Individualised Perioperative Open-Lung Ventilation Strategy During One-Lung Ventilation (iPROVE-OLV)" trial demonstrated the feasibility of individualized open-lung ventilation strategies during OLV, whereas the recently published "Protective ventilation with high *versus* low positive end-expiratory pressure during one-lung ventilation for thoracic surgery (PROTHOR)" trial confirmed the importance of optimizing ventilatory management to reduce PPCs following thoracic surgery.[8,14] These findings, together with accumulating evidence regarding driving-pressure-guided ventilation and individualized positive end-expiratory pressure (PEEP) titration, have progressively reshaped contemporary clinical practice.[15-17]

Similarly, postoperative analgesia has undergone substantial evolution over the last decade. Although thoracic epidural analgesia has historically represented the reference standard, ultrasound-guided fascial plane blocks – particularly erector spinae plane (ESP) block and thoracic paravertebral block (PVB) – have become increasingly integrated into multimodal opioid-sparing analgesic strategies because of their favorable balance between efficacy, safety, and technical simplicity.[10-13]

Despite the availability of international guidelines and growing evidence supporting standardized perioperative pathways, implementation remains heterogeneous among institutions because of differences in organizational resources, local protocols, and clinical expertise.[4,5] Consequently, real-world data describing current anesthetic practice are essential to evaluate adherence to evidence-based recommendations and to identify opportunities for further quality improvement.

The Campania Region (Southern Italy) represents one of the largest thoracic surgery networks in Southern Italy, including several high-volume referral centers with established expertise in thoracic anesthesia. However, contemporary perioperative anesthetic practice across these institutions has not previously been systematically investigated.

Therefore, the present multicenter survey aimed to characterize current perioperative anesthetic management in thoracic surgery across hospitals in the Campania Region, with particular emphasis on preoperative optimization, intraoperative ventilation, regional analgesia, and postoperative care pathways. By identifying areas of consensus as well as aspects characterized by greater variability, this study seeks to provide a contemporary overview of regional clinical practice and to identify potential targets for future quality-improvement initiatives.

Materials and Methods

Study design

This multicenter cross-sectional observational study was conducted using an anonymous web-based survey to characterize current perioperative anesthetic practice in thoracic surgery across hospitals in the Campania Region. The study followed the recommendations of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for observational research whenever applicable.[18]

Study population

Eligible participants were board-certified consultant anesthesiologists routinely involved in the perioperative management of adult patients undergoing thoracic surgery. The survey included clinicians practicing in seven hospitals within the Campania Region, comprising tertiary referral centers, university hospitals, IRCCS institutions, and accredited private hospitals. Participation was voluntary and anonymous. Because the objective of the study was to describe institutional clinical practice, only physicians directly involved in thoracic anesthesia were invited to participate.

Survey development

A structured questionnaire consisting of 21 multiple-choice questions was developed to investigate perioperative management throughout the surgical pathway. The questionnaire explored four predefined domains: hospital characteristics; preoperative assessment and optimization; intraoperative anesthetic and ventilatory management; and postoperative recovery pathways.

Questions specifically addressed anesthetic maintenance techniques, airway management, lung isolation, OLV, regional anesthesia, postoperative destination, and implementation of respiratory physiotherapy protocols. The questionnaire was designed to require approximately 5-10 minutes to complete in order to maximize participation while maintaining comprehensive assessment of routine clinical practice. Prior to distribution, the questionnaire underwent face validation by a panel of senior thoracic anesthesiologists.

Data collection

The questionnaire was administered electronically between 1 April and 30 April 2026. Responses were collected anonymously through an online survey platform. Only completed questionnaires were included in the final analysis. No participant identifiers or patient-level clinical data were collected.

Outcomes

The primary objective of the study was to describe current perioperative anesthetic practice across participating institutions. Secondary objectives included evaluating variability in anesthetic maintenance techniques; lung isolation devices; intraoperative ventilatory strategies; regional analgesia; and postoperative organizational pathways.

Statistical analysis

Given the descriptive nature of the survey, statistical analyses were limited to descriptive statistics. Categorical variables are reported as absolute frequencies and percentages. Continuous variables, where applicable, are presented as mean ± standard deviation or median (interquartile range), according to data distribution. No inferential statistical analyses were planned because the purpose of the study was to describe contemporary clinical practice rather than to compare predefined groups. Statistical analyses were performed using IBM SPSS Statistics.

Results

Participants and hospital characteristics

A total of 40 consultant anesthesiologists from seven hospitals across the Campania Region completed the survey. Most respondents (92.5%) practiced in tertiary referral (Hub) hospitals, while only a small proportion were affiliated with accredited private institutions. Participating centers were predominantly high-volume thoracic surgery units, with 84.6% of respondents working in hospitals performing more than 150 thoracic procedures annually (Table 1). Overall, the survey population reflects anesthetic practice within specialized referral centers responsible for the majority of thoracic surgical activity in the region.

Table 1. Characteristics of participating centers and respondents.

	n	%
Hospital type		
Tertiary referral (Hub) hospital	37	92.5
Accredited private hospital	3	7.5
Annual thoracic surgical volume*		
<50 procedures/year	1	2.6
50-150 procedures/year	5	12.8
>150 procedures/year	33	84.6

*Based on 39 responses.

Table 2. Intraoperative anesthetic management.

	n	%
Maintenance of anesthesia		
Balanced volatile anesthesia	19	47.5
TIVA	19	47.5
Other techniques	2	5.0
TIVA modality		
TCI	16	40.0
Conventional TIVA	3	7.5
Preferred lung isolation device		
DLT	24	60.0
DLT or bronchial blocker according to case	16	40.0
PEEP strategy during OLV		
Individualized PEEP	25	62.5
Fixed PEEP	15	37.5

TIVA, total intravenous anesthesia; TCI, target-controlled infusion; DLT, double-lumen tube; PEEP, positive end-expiratory pressure; OLV, one-lung ventilation.

Table 3. Regional analgesia and postoperative management.

	n	%
Ultrasound-guided regional anesthesia		
Routinely performed	30	75.0
Occasionally performed	10	25.0
Never performed	0	0
Postoperative destination		
Surgical ward	25	62.5
Intensive care unit	14	35.0
PACU/High-dependency unit	1	2.5
Structured respiratory physiotherapy protocol*		
Yes	18	46.2
No	21	53.8

PACU, post-anesthesia care unit; *based on 39 responses.

Intraoperative anesthetic management

Balanced volatile anesthesia and total intravenous anesthesia (TIVA) were adopted with comparable frequency, indicating the absence of a predominant maintenance strategy among participating institutions (Table 2). Double-lumen tubes (DLTs) represented the preferred device for lung isolation. However, a substantial proportion of respondents reported selecting either DLTs or bronchial blockers according to individual patient characteristics and surgical requirements, suggesting a personalized approach to airway management.

Lung-protective ventilation during OLV was consistently implemented across all participating centers. Although PEEP was routinely applied by every respondent, most anesthesiologists reported individualizing PEEP according to intraoperative physiological variables rather than using standardized ventilatory settings (Table 2).

Regional analgesia

Ultrasound-guided regional anesthesia was universally incorporated into perioperative practice. Three-quarters of respondents routinely performed regional blocks, whereas the remaining participants used these techniques selectively. Notably, none of the surveyed anesthesiologists reported never performing ultrasound-guided regional anesthesia, highlighting its widespread integration into contemporary thoracic anesthesia (Table 3).

Postoperative management

Postoperative care pathways were characterized by greater organizational variability than intraoperative management. Most patients were transferred directly to the surgical ward following surgery, whereas admission to the intensive care unit was reserved for selected cases. Dedicated post-anesthesia care units or intermediate-care facilities were available only in a minority of institutions. Similarly, implementation of structured respiratory physiotherapy protocols varied considerably among centers, with almost equal proportions of respondents reporting the presence or absence of standardized postoperative rehabilitation pathways (Table 3). Overall, the survey demonstrated a high degree of standardization regarding intraoperative anesthetic management, whereas greater heterogeneity emerged in postoperative organizational pathways.

Discussion

The present multicenter survey provides a contemporary snapshot of perioperative anesthetic practice across high-volume thoracic surgery centers in Southern Italy. Three principal findings emerged. First, evidence-based intraoperative strategies, including lung-protective OLV and ultrasound-guided regional anesthesia, have been widely incorporated into routine clinical practice. Second, volatile anesthesia and TIVA were adopted with similar frequency, suggesting that anesthetic maintenance is increasingly individualized rather than protocol-driven. Third, the greatest variability was observed in postoperative organizational pathways, particularly regarding respiratory physiotherapy and intermediate-care facilities. Together, these findings indicate that while intraoperative thoracic anesthesia has become highly standardized, postoperative care remains the principal target for future quality-improvement initiatives.

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Evidence-based intraoperative management

One of the most encouraging findings of this survey is the widespread implementation of lung-protective ventilation during OLV. Every respondent reported the routine application of PEEP, while most anesthesiologists individualized ventilatory settings according to patient-specific physiological variables. These findings are consistent with the progressive evolution of thoracic anesthesia toward personalized respiratory management, moving beyond fixed ventilatory parameters to strategies based on respiratory mechanics and lung recruitability.[14-17,19,20] The growing emphasis on individualized ventilation is supported by recent high-quality evidence. The multicenter iPROVE-OLV trial demonstrated the feasibility of an individualized open-lung ventilation strategy during OLV, incorporating recruitment maneuvers, compliance-guided PEEP titration, and personalized postoperative respiratory support.[8] More recently, the international PROTHOR trial further strengthened the concept that intraoperative ventilatory management influences postoperative pulmonary outcomes following thoracic surgery, reinforcing current recommendations favoring protective ventilation strategies.[14] These observations, together with evidence supporting driving-pressure-guided ventilation, suggest that individualized respiratory management should now be considered a core component of contemporary thoracic anesthesia rather than an optional adjunct.[15,16]

Interestingly, no clear preference emerged regarding maintenance of general anesthesia. Balanced volatile anesthesia and TIVA were used with similar frequency across participating institutions, reflecting the absence of convincing evidence supporting the superiority of either technique when integrated into a modern ERAS pathway. Current perioperative recommendations emphasize that postoperative outcomes are more strongly influenced by comprehensive implementation of evidence-based perioperative care than by the choice of hypnotic agent alone.[1,6,7,10]

Regional anesthesia: from innovation to routine practice

The universal adoption of ultrasound-guided regional anesthesia represents perhaps the most relevant finding of this survey. Over the past decade, thoracic anesthesia has undergone a profound shift from routine thoracic epidural analgesia toward ultrasound-guided regional techniques. Although thoracic epidural analgesia remains an effective option, concerns regarding hypotension, urinary retention, technical complexity, and contraindications have encouraged increasing adoption of thoracic PVB, ESP block, and other fascial plane techniques.[10] The present findings closely reflect this international trend. Every respondent reported using ultrasound-guided regional anesthesia either routinely or selectively, indicating that these techniques have become fully integrated into everyday clinical practice rather than representing innovative procedures confined to specialized centers. Recent evidence supports this evolution. A meta-analysis by Fenta *et al.* demonstrated that thoracic PVB may provide superior postoperative analgesia compared with ESP block in selected clinical settings.[11] Nevertheless, more recent reviews have highlighted the remarkable diffusion of ESP block, largely attributable to its favorable balance between technical simplicity, reproducibility, safety, and clinically meaningful analgesic efficacy.[12,13] Rather than identifying a single superior block, current literature increasingly supports an individualized approach in which the regional technique is selected according to surgical procedure, patient characteristics, operator expertise, and institutional practice.[10-13]

Airway management and lung isolation

Although airway management was not the primary focus of the survey, the predominance of DLTs observed among participating centers deserves consideration. The recent European Association of Cardiothoracic Anesthesiology and Intensive Care consensus document recommends DLTs as the preferred lung-isolation device for most thoracic surgical procedures, while recognizing bronchial blockers as valuable alternatives in selected patients, including those with anticipated difficult airways or requiring postoperative mechanical ventilation.[21] The substantial proportion of respondents reporting routine use of both DLTs and bronchial blockers therefore reflects a flexible, patient-centered approach rather than inconsistency in clinical practice, further supporting the high level of expertise within participating institutions.

Postoperative organization: the remaining challenge

In contrast to the high degree of standardization observed during intraoperative management, postoperative organizational pathways appeared considerably more heterogeneous. Nearly half of participating institutions lacked structured respiratory physiotherapy protocols, and dedicated post-anesthesia care or intermediate-care facilities were available only in a minority of centers. These findings suggest that organizational aspects of perioperative care have evolved less uniformly than anesthetic techniques themselves. This observation is particularly relevant in light of current ERAS recommendations, which emphasize that successful recovery depends on coordinated multidisciplinary interventions extending well beyond the operating room. Early mobilization, structured respiratory rehabilitation, standardized analgesic pathways, and close postoperative monitoring are all integral components of enhanced recovery after lung surgery.[6,7] Consequently, the benefits achieved through optimized intraoperative management may be only partially realized when postoperative pathways remain inconsistent across institutions.

Clinical implications

The present findings have several practical implications. First, they demonstrate that contemporary evidence-based intraoperative thoracic anesthesia has been successfully implemented across high-volume centers within the Campania Region. Second, they identify postoperative organization – not intraoperative anesthetic technique – as the principal area requiring further standardization. Future quality-improvement initiatives should therefore prioritize the implementation of structured respiratory rehabilitation programs, shared postoperative care pathways, and multidisciplinary ERAS protocols rather than focusing exclusively on additional technological advances. Finally, this survey provides a benchmark against which future regional audits may be compared. Periodic reassessment of perioperative practice, combined with prospective collection of clinical outcome data, could facilitate continuous quality improvement while promoting greater consistency among institutions.

Strengths and limitations

The principal strength of this study lies in its multicenter design and the inclusion of anesthesiologists practicing in institutions responsible for the majority of thoracic surgical activity within the Campania Region. Consequently, the survey provides a realistic overview of contemporary practice across a high-volume regional network. Several limitations should nevertheless be acknowledged. First, the survey reflects self-reported clinical practice and therefore cannot verify actual adherence to institutional protocols. Second, the descriptive design precludes assessment of associations between perioperative strategies and patient outcomes. Finally, because participating institutions were predominantly tertiary referral centers, the findings may not be fully generalizable to lower-volume hospitals or healthcare systems with different organizational structures.

Conclusions

Future studies should combine surveys with prospective clinical audits evaluating adherence to ERAS pathways and their impact on postoperative outcomes, thereby moving from description of practice to assessment of quality of care.

References

1. Batchelor TJP, Rasburn NJ, Abdelnour-Berchtold E, et al. Guidelines for enhanced recovery after lung surgery: recommendations of the Enhanced Recovery After Surgery (ERAS®) Society and the European Society of Thoracic Surgeons (ESTS). Eur J Cardiothorac Surg 2019;55:91-115.
2. Hu XY, Du B. Lung-protective ventilation during one-lung ventilation: known knowns, and known unknowns. J Thorac Dis 2019;11:S237-40.
3. Lohser J, Slinger P. Lung Injury After One-Lung Ventilation: A Review of the Pathophysiologic Mechanisms Affecting the Ventilated and the Collapsed Lung. Anesth Analg 2015;121:302-18.
4. Miskovic A, Lumb AB. Postoperative pulmonary complications. Br J Anaesth 2017;118:317-34.
5. Karzai W, Schwarzkopf K. Hypoxemia during one-lung ventilation: prediction, prevention, and treatment. Anesthesiology 2009;110:1402-11.
6. Powers BK, Ponder HL, Findley R, et al.; Enhanced Recovery Comparative Pharmacotherapy Collaborative. Enhanced recovery after surgery (ERAS®) Society abdominal and thoracic surgery recommendations: A systematic review and comparison of guidelines for perioperative and pharmacotherapy core items. World J Surg 2024;48:509-23.
7. Cohen JB, Smith BB, Teeter EG. Update on guidelines and recommendations for enhanced recovery after thoracic surgery. Curr Opin Anaesthesiol 2024;37:58-63.
8. Ferrando C, Carramiñana A, Piñeiro P, et al. Individualised, perioperative open-lung ventilation strategy during one-lung ventilation (iPROVE-OLV): a multicentre, randomised, controlled clinical trial. Lancet Respir Med 2024;12:195-206.
9. Sha Y, Xu R, Shao S, et al. Tailored single-lung ventilation approaches and postoperative pulmonary outcomes in thoracic surgery. J Thorac Dis 2025;17:5371-87.
10. Mitchell J, Couvreur C, Forget P. Recent Advances in Perioperative Analgesia in Thoracic Surgery: A Narrative Review. J Clin Med 2024;14:38.
11. Fenta E, Kibret S, Hunie M, et al. The analgesic efficacy of erector spinae plane block versus paravertebral block in thoracic surgeries: a meta-analysis. Front Med (Lausanne) 2023;10:1208325.
12. Gonçalves JPF, de Castro APCR, Albuquerque LG, et al. The expanding role of the erector spinae plane block: from concept to clinical integration. Braz J Anesthesiol 2025;75:844644.
13. Zhang YC, Sun Y, Li SH, et al. Clinical effects, mechanisms and spread of erector spinae plane block and paravertebral block in thoracic and breast surgery: a narrative review. Int J Surg 2025;111:9507-19.
14. Writing Committee; Steering Committee; PROTHOR Collaborative Group; PROtective VEntilation Network (PROVE Network) for the Clinical Trial Network of the European Society of Anaesthesiology and Intensive Care. Effects of intraoperative higher versus lower positive end-expiratory pressure during one-lung ventilation for thoracic surgery on postoperative pulmonary complications (PROTHOR): a multicentre, international, randomised, controlled, phase 3 trial. Lancet Respir Med 2026;14:17-28.
15. Park M, Yoon S, Nam JS, et al. Driving pressure-guided ventilation and postoperative pulmonary complications in thoracic surgery: a multicentre randomised clinical trial. Br J Anaesth 2023;130:e106-18.
16. Neto AS, Hemmes SN, Barbas CS, et al.; PROVE Network Investigators. Association between driving pressure and development of postoperative pulmonary complications in patients undergoing mechanical ventilation for general anaesthesia: a meta-analysis of individual patient data. Lancet Respir Med 2016;4:272-80. Erratum in: Lancet Respir Med 2016;4:e34.
17. Gu WJ, Zhao FZ, Piccioni F, et al. Individualized PEEP titration by lung compliance during one-lung ventilation: a meta-analysis. Crit Care 2025;29:27.
18. Cuschieri S. The STROBE guidelines. Saudi J Anaesth 2019;13:S31-4.
19. Peel JK, Funk DJ, Slinger P, et al. Positive end-expiratory pressure and recruitment maneuvers during one-lung ventilation: A systematic review and meta-analysis. J Thorac Cardiovasc Surg 2020;160:1112-22.e3.
20. Güldner A, Kiss T, Serpa Neto A, et al. Intraoperative protective mechanical ventilation for prevention of postoperative pulmonary complications: a comprehensive review of the role of tidal volume, positive end-expiratory pressure, and lung recruitment maneuvers. Anesthesiology 2015;123:692-713.
21. Granell M, Vanpeteghem C, Mourisse J, et al. Airway Management in Thoracic Anesthesia: EACTAIC Consensus Document. J Cardiothorac Vasc Anesth 2026;40:1276-87.

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Availability of data and materials: the datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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