Open Access Article

Ann. Acad. Med. Siles. (online) 2025; 79: 276–281
eISSN 1734-025X
DOI: 10.18794/aams/205576
www.annales.sum.edu.pl

PRACA ORYGINALNA
ORIGINAL PAPER

The influence of fluid restriction on the patient's water distribution during video-assisted thoracoscopy (VATS) – A preliminary report

Wpływ restrykcji płynowej na dystrybucję wody u pacjenta podczas wideotorakoskopii (VATS) – doniesienie wstępne

Piotr Wichary[1], Denis Kowalski[1], Martyna Czaja[2], Sławomir Mika[3], Jolanta Zalejska-Fiolka[4], Szymon Białka[1]

[1]Department of Anaesthesiology and Critical Care, Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Katowice, Poland

[2]University Clinical Center named after Prof. K. Gibiński of the Medical University of Silesia in Katowice, Poland

[3]Medica Co., Ltd. (Upper Silesian School of Ultrasonography), Chorzów, Poland

[4]Department of Biochemistry, Faculty of Medical Sciences in Zabrze, Medical University of Silesia in Katowice, Poland

ABSTRACT

INTRODUCTION: The principles of optimal perioperative fluid therapy in thoracic surgery have been discussed for many years due to its possible role in pulmonary complications. The aim of the study was to perform a preoperative analysis of bioelectrical impedance (BIA) in patients undergoing video-assisted thoracoscopic surgery (VATS) using one-lung ventilation.

MATERIAL AND METHODS: The study comprised 14 adult patients (11 men and 3 women). BIA was applied to measure total body water (TBW), intracellular body water (ICW), and extracellular body water (ECW) prior to the operation and after the patient's return to the ward. The patients were grouped according to the total water received during the surgery per kilogram of body weight. The accepted cut-off value for restrictive fluid therapy was < 6.5 ml/kg of all fluids received during surgery.

RESULTS: A small elevation of TBW was observed after the surgeries as compared to preoperational values. In restrictive fluid therapy, the values raised from 46.55% (95% CI: 41.58; 51.58) to 46.92% (95% CI: 42.92; 51.32), while for liberal volumes of fluids given during the procedures, the values grew from 37.26% (95% CI: 37.97; 41.56) to 37.63% (95% CI: 33.82; 41.43). However, the differences were not statistically significant (p = 0.983) and fluctuations in the intracellular and extracellular water were unremarkable in both groups.

Received: 07.04.2025 **Revised:** 23.04.2025 **Accepted:** 26.05.2025 **Published online:** 11.09.2025

Address for correspondence: lek. Piotr Wichary, Zakład Badania i Leczenia Bólu, Wydział Nauk Medycznych w Zabrzu ŚUM, ul. 3 Maja 13, 41-800 Zabrze, tel. +48 32 370 45 93, e-mail: piotr.wichary@sum.edu.pl

Publisher: Medical University of Silesia, Katowice, Poland

CONCLUSIONS: Restrictive fluid therapy does not affect intracellular and extracellular water distribution in patients undergoing VATS.

KEYWORDS

VATS, water distribution, video-assisted thoracoscopy, total body water, bioelectrical impedance analysis, restrictive fluid therapy, perioperative fluid therapy, TBW

STRESZCZENIE

WSTĘP: Zasady prowadzenia optymalnej płynoterapii okołooperacyjnej w trakcie zabiegów torakochirurgicznych są przedmiotem debaty od wielu lat z powodu możliwego związku z rozwojem powikłań płucnych. Celem badania była analiza wpływu płynoterapii restrykcyjnej z użyciem impedancji bioelektrycznej (*bioelectrical impedance analysis* – BIA) u pacjentów poddawanych operacjom wideotorakoskopowym (*video-assisted thoracoscopic surgery* – VATS) z wentylacją jednym płucem.
MATERIAŁ I METODY: Badanie przeprowadzono u 14 dorosłych pacjentów (11 mężczyzn i 3 kobiety). Za pomocą BIA dokonywano pomiarów wody całkowitej (*total body water* – TBW), wewnątrzkomórkowej (*intracellular body water* – ICW) i zewnątrzkomórkowej (*extracellular body water* – ECW) przed operacją oraz po powrocie pacjenta na salę chorych. Pacjentów podzielono ze względu na całkowitą ilość płynów otrzymanych podczas operacji w przeliczeniu na kilogram masy ciała. Za wartość graniczną dla restrykcyjnej płynoterapii przyjęto < 6,5 ml/kg wszystkich płynów podanych podczas operacji.
WYNIKI: Po zabiegach obserwowano niewielki wzrost ilości TBW w porównaniu z wartościami przedoperacyjnymi. Dla restrykcyjnej płynoterapii wartości wzrosły z 46,55% (95% CI = 41,58; 51,58) do 46,92% (95% CI = 42,92; 51,32), natomiast w przypadku dowolnej ilości podanych płynów z 37,26% (95% CI = 37,97;41,56) do 37,63% (95% CI = 33,82; 41,43). Jednak różnice te nie były istotne statystycznie (p = 0,983). Wahania w ilości wody wewnątrzkomórkowej i zewnątrzkomórkowej w obu grupach były nieznaczne.
WNIOSKI: Płynoterapia restrykcyjna nie wpływa na dystrybucję wody wewnątrzkomórkowej i zewnątrzkomórkowej u pacjentów poddawanych VATS.

SŁOWA KLUCZOWE

VATS, dystrybucja wody, wideotorakoskopia, całkowita zawartość wody w organizmie, analiza impedancji bioelektrycznej, płynoterapia restrykcyjna, płynoterapia okołooperacyjna, TBW

INTRODUCTION

The guidelines for optimal perioperative fluid therapy during thoracic surgery have been discussed for many years due to possible development of pulmonary complications [1,2,3,4,5]. Pulmonary complications have been recognized as a cause of markedly poorer recovery after thoracic procedures and constitute a major burden to the healthcare system, including increased costs [6,7]. For a long time now, restrictive fluid supply has been considered an optimal regimen that can restrict the development of pulmonary complications. However, such opinions have also been contested for potential association with other complications, e.g., organ hypoperfusion leading to dysfunction and failure, particularly manifested in acute renal insufficiency [8]. On the other hand, the evaluation of water distribution has been found helpful in assessing the risk of complications such as infection or edema [9,10]. An effective method for estimating body composition, particularly the distribution of water, body fat, and muscle mass, is bioelectrical impedance analysis (BIA). It involves the flow of a weak electric current through the body, the voltage of which is measured to calculate the body's impedance, or its ability to attenuate the current. It has been established that fat does not conduct electricity, and that fat-free body mass is considered a conductive volume that helps electric current flow due to the conductivity of electrolytes dissolved in water. Impedance is made up of resistance and reactance. In biological systems, resistance is due to the total water in the body, while reactance occurs because of the capacitance of the cell membrane. This allows us to measure the values of cellular water as well as extracellular water [11]. This method has been used in research to estimate and analyze changes in disorders of various types of diseases, including in critically ill patients [12,13,14]. The objective of this study was to evaluate the effect of restrictive fluid therapy on water distribution in patients undergoing video-assisted thoracoscopy (VATS) with one-lung ventilation (OLV), using BIA.

MATERIAL AND METHODS

The study comprised 14 adult patients (11 men and 3 women; mean age: 60.5 ± 9.574) undergoing VATS for diagnostic or therapeutic reasons. The mean weights recorded in the liberal and restrictive fluid therapy groups were 72.65 kg (± 7.21 kg) and 79.48 kg

(± 11.52 kg), respectively. Similarly, the mean heights were 169.25 cm (± 5.11 cm) and 177.83 cm (± 4.26 cm), respectively. The study was approved by the Bioethical Committee of the Medical University of Silesia (No. PCN/0022/KB1/08/II/20). All the surgeries were scheduled in advance. The American Society of Anesthesiologists (ASA) scale was used to qualify the patients into groups II or III (Table I). Anesthesia was uniform in both groups and entailed IV administration of propofol (Propofol-Lipuro B. Braun, Germany), fentanyl (Fentanyl WZF, Polfa Warszawa S.A., Poland), and cis-atracurium (Cisatracurium Kalceks AS Kalceks, Latvia). OLV was ensured with a Robertshaw double lumen endotracheal tube. Anesthesia was supported by sevoflurane (Sevoflurane Baxter, Baxter SA, Belgium) at a dosage of 2% v/v and fractional doses of fentanyl and cis-atracurium. FiO_2 1.0 was used during ventilation. The duration of the procedure ranged between 40 and 100 min (average 63.88 min). The patients were grouped according to the total water received during the surgery per kilogram of body weight. They were assigned to groups at random by tossing a coin. The test group included patients receiving targeted fluid therapy (n = 8). The accepted cut-off value for restrictive fluid therapy was < 6.5 ml/kg of all fluids received during surgery. The patients received Sterofundin ISO balanced full electrolyte solution (B. Braun Melsungen AG, Germany). Body composition was evaluated with an Accuniq BC310 analyzer (SELVAS Healthcare Inc., South Korea) in a standing position following the manufacturers' instructions. To avoid measurement errors, the results were automatically calculated using three different frequencies (5, 50, and 250 kHz). The measurements were taken in the evening preceding the surgery and after the patient's return to the ward (before oral hydration was administered). The statistical analysis was conducted with the software program Statistica 12. Normal data distribution was assessed using the Kolmogorov–Smirnov test. In order to compare variables between the groups, ANOVA was used for repeated measures, with the results presented as mean values and standard deviation. Post hoc analysis made use of the Bonferroni test. The accepted cut-off for statistical significance was $p < 0.05$.

Table I. Qualification of patients for individual groups by American Society of Anesthesiologists (ASA) scale grading

ASA grading	Number of patients (n)
II	8
III	6
IV	–

RESULTS

Water distribution was evaluated taking into consideration the parameters of total body water (TBW), intracellular body water (ICW), and extracellular body water (ECW). A statistically significant difference was observed between the test group and the control group for each of these parameters. The average TBW value for the group receiving restrictive volumes of fluids was 46.73%, while the controls showed a mean value of 37.45%. Respectively, the groups' observed values for ICW were 27.75% and 22.19%, while for ECW they were 18.99% and 15.26%. The values of all parameters were markedly higher in the test group as compared to the controls (Table II).

Table II. Comparison of mean total, intracellular, and extracellular body water in the test and control groups

Group	TBW (p = 0.007)	ICW (p = 0.007)	ECW (p = 0.007)
Test group (1) < 6.5 ml/kg	**46.73%** (95% CI = 42.07; 51.40)	**27.75%** (95% CI = 24.91; 30.58)	**18.99%** (95% CI = 17.09; 20.88)
Controls (2) > 6.5 ml/kg	**37.45%** (95% CI = 33.40; 41.49)	**22.19%** (95% CI = 19.74; 24.64)	**15.26%** (95% CI = 13.61; 16.90)

TBW – total body water; ICW – intracellular body water; ECW – extracellular body water.

Both groups showed some increase in TBW following the surgery over the preoperative values (Table III). In restrictive fluid therapy, the values were 46.55% and 46.92%, respectively; for liberal fluid supply, they were 37.26% and 37.63%, respectively. However, the differences were not statistically significant (p = 0.983). Fluctuations in the intracellular-to-extracellular-water ratio were unremarkable in both groups. ICW levels in the patients supplied with fluids at a volume of < 6.5 ml/kg amounted to 27.51% before the surgery and 27.98% afterwards. The controls showed mean values of 22.14% and 22.24%, respectively (Table IV). Such results did not correspond to the level of statistical significance chosen for the study. The p-value for ICW amounted to 0.464. Similarly, measurements of ECW were 19.03% prior to surgery and, paradoxically, as high as 18.94% after the procedures. In the control group, these values were 15.12% and 15.38%, respectively (Table V).

Table III. Comparison of total body water (TBW) prior to and after surgery in the test and control groups

Group	Time	Mean (%)	-95.00% (%)	+95.00% (%)	p
Test group (1)	TBW preoperative	46.55	41.58	51.51	0.983
< 6.5 ml/kg	TBW postoperative	46.92	42.52	51.32	
Controls (2)	TBW preoperative	37.26	32.97	41.56	
> 6.5 ml/kg	TBW postoperative	37.63	33.82	41.43	

Table IV. Comparison of intracellular body water (ICW) prior to and after surgery in the test and control groups

Group	Time	Mean (%)	-95.00% (%)	+95.00% (%)	p
Test group (1)	ICW preoperative	27.51	24.59	30.43	0.464
< 6.5 ml/kg	ICW postoperative	27.98	25.19	30.77	
Controls (2)	ICW preoperative	22.14	19.61	24.67	
> 6.5 ml/kg	ICW postoperative	22.24	19.82	24.66	

Table V. Comparison of extracellular body water (ECW) prior to and after surgery in the test and control groups

Group	Time	Mean (%)	-95.00% (%)	+95.00% (%)	p
Test group (1)	ECW preoperative	19.03	16.96	21.10	0.264
< 6.5 ml/kg	ECW postoperative	18.94	17.20	20.68	
Controls (2)	ECW preoperative	15.12	13.33	16.91	
> 6.5 ml/kg	ECW postoperative	15.38	13.87	16.89	

DISCUSSION

Our study analyzed bioelectric impedance in patients undergoing thoracoscopic surgery according to the adopted method of perioperative fluid therapy. Our results indicate no effect of the volume of supplied crystalloids on body water distribution after the selected thoracic surgeries. Both restrictive and liberal volumes of fluid resulted in unremarkable fluctuations in water parameters, with a minor increase in TBW after the surgery. Also, no statistical fluctuations in ICW and ECW were observed.

The available literature fails to illustrate multiple studies in the area of this important, nevertheless controversial issue. A similar study was carried out upon resection of the esophagus, where fluid dynamics was evaluated during the perioperative period. The authors suggested the potential for forecasting the occurrence of infection on the basis of BIA. Contrary to our study, the volumes of ECW and the ECW/TBW ratio were elevated during the postoperative period [9]. Another analysis was carried out by Wu et al. [15] in a retrospective, single-center observational study comprising 446 adults undergoing minimally invasive lobectomy. The participants supplied with crystalloids were divided into four groups depending on the volume of fluid per kilogram of body weight during one hour of the procedure, while the patients receiving colloids were divided into three groups. The results illustrate that both restrictive and liberal fluid therapy with crystalloids led to a worse course in the postoperative period and a greater incidence of complications. Interestingly, similar negative effects were observed in the patients who did not receive colloids or when their supply was strictly limited. The study bears numerous limitations, however, including a long list of exclusions for the subjects; therefore, any final conclusions should be approached very cautiously. The exact effect of colloids during thoracic surgery remains unclear. Studies on colloid therapies have drawn some conflicting conclusions, but they comprised inconsistent groups of patients suffering from different predominant conditions [16,17,18,19,20]. A possible alternative seems to be a targeted therapy, though it demands additional hemodynamic monitoring. Also, the benefits themselves are not clear, as the results originate from studies in areas other than thoracic surgery with OLV [21,22,23,24]. Numerous authors claim that fluid therapy should be an individually selected regimen managed by an interdisciplinary team to take into consideration the predominant condition, any concomitant diseases, and the general health status of the patient [15,25,26]. The concept of BIA is a recent development in thoracic surgery research. A team of researchers in Italy have utilized BIA to identify a substantial occurrence of fluid retention subsequent to lobectomy. Their conclusion was that BIA constituted an accessible, reproducible, and non-invasive technique for the assessment and early detection of fluid retention. The present study found no correlation between fluid retention and the duration of anesthesia, gender, age, blood loss, or body mass index [27]. Another study used BIA in a repeat lobectomy with the VATS method, with the objective of measuring the effect of tumor removal on body weight [28].

CONCLUSIONS

Adequate perioperative fluid therapy is considered key to reducing postoperative pulmonary complications. There is no proven effect of restrictive fluid therapy on water balance in patients undergoing VATS.

Limitations

When interpreting the results of this study, it is important to consider its limitations. The measurements were obtained using a device that has only been employed on two occasions in the context of scientific studies. The measurement was taken in a standing position, which is not feasible for a significant number of thoracic surgery patients immediately after surgery. The random selection of patients in the small sample could have influenced the results. Therefore, it is necessary to conduct further studies comprising a larger cohort of patients.

Authors' contribution

Study design – S. Białka, J. Zalejska-Fiolka
Data collection – P. Wichary, D. Kowalski, M. Czaja
Data interpretation – S. Białka, P. Wichary, D. Kowalski
Statistical analysis – S. Białka, P. Wichary, D. Kowalski
Manuscript preparation – P. Wichary, D. Kowalski, S. Mika
Literature research – P. Wichary, D. Kowalski, S. Mika

REFERENCES

1. Licker M., de Perrot M., Spiliopoulos A., Robert J., Diaper J., Chevalley C. et al. Risk factors for acute lung injury after thoracic surgery for lung cancer. Anesth. Analg. 2003; 97(6): 1558–1565, doi: 10.1213/01.ANE.0000087799.85495.8A.
2. Alam N., Park B.J., Wilton A., Seshan V.E., Bains M.S., Downey R.J. et al. Incidence and risk factors for lung injury after lung cancer resection. Ann. Thorac. Surg. 2007; 84(4): 1085–1091, doi: 10.1016/j.athoracsur.2007.05.053.
3. Mizuno Y., Iwata H., Shirahashi K., Takamochi K., Oh S., Suzuki K. et al. The importance of intraoperative fluid balance for the prevention of postoperative acute exacerbation of idiopathic pulmonary fibrosis after pulmonary resection for primary lung cancer. Eur. J. Cardiothorac. Surg. 2012; 41(6): e161–e165, doi: 10.1093/ejcts/ezs147.
4. Arslantas M.K., Kara H.V., Tuncer B.B., Yildizeli B., Yuksel M., Bostanci K. et al. Effect of the amount of intraoperative fluid administration on postoperative pulmonary complications following anatomic lung resections. J. Thorac. Cardiovasc. Surg. 2015; 149(1): 314––320, 321.e1, doi: 10.1016/j.jtcvs.2014.08.071.
5. Matot I., Dery E., Bulgov Y., Cohen B., Paz J., Nesher N. Fluid management during video-assisted thoracoscopic surgery for lung resection: a randomized, controlled trial of effects on urinary output and postoperative renal function. J. Thorac. Cardiovasc. Surg. 2013; 146(2): 461–466, doi: 10.1016/j.jtcvs.2013.02.015.
6. Agostini P., Cieslik H., Rathinam S., Bishay E., Kalkat M.S., Rajesh P.B. et al. Postoperative pulmonary complications following thoracic surgery: are there any modifiable risk factors? Thorax 2010; 65(9): 815––818, doi: 10.1136/thx.2009.123083.
7. Lugg S.T., Agostini P.J., Tikka T., Kerr A., Adams K., Bishay E. et al. Long-term impact of developing a postoperative pulmonary complication after lung surgery. Thorax 2016; 71(2): 171–176, doi: 10.1136/thoraxjnl-2015-207697.
8. Koksal G.M., Erbabacan E., Esquinas A.M. Effects of intraoperative fluid management on postoperative outcome: What is our limit in fluid therapy? Ann. Surg. 2018; 268(6): e43, doi: 10.1097/SLA.0000000000002490.
9. Oya S., Yamashita H., Iwata R., Kawasaki K., Tanabe A., Yagi K. et al. Perioperative fluid dynamics evaluated by bioelectrical impedance analysis predict infectious surgical complications after esophagectomy. BMC Surg. 2019; 19(1): 184, doi: 10.1186/s12893-019-0652-z.
10. Chong J.U., Nam S., Kim H.J., Lee R., Choi Y., Lee J.G. et al. Exploration of fluid dynamics in perioperative patients using bioimpedance analysis. J. Gastrointest. Surg. 2016; 20(5): 1020–1027, doi: 10.1007/s11605-015-3063-1.
11. Khalil S.F., Mohktar M.S., Ibrahim F. The theory and fundamentals of bioimpedance analysis in clinical status monitoring and diagnosis of diseases. Sensors (Basel) 2014; 14(6): 10895–10928, doi: 10.3390/s140610895.
12. Lee Y.H., Lee J.D., Kang D.R., Hong J., Lee J.M. Bioelectrical impedance analysis values as markers to predict severity in critically ill patients. J. Crit. Care 2017; 40: 103–107, doi: 10.1016/j.jcrc.2017.03.013.
13. Ward L.C. Bioelectrical impedance analysis for body composition assessment: reflections on accuracy, clinical utility, and standardisation. Eur. J. Clin. Nutr. 2019; 73(2): 194–199, doi: 10.1038/s41430-018-0335-3.
14. Chung Y.J., Kim E.Y. Usefulness of bioelectrical impedance analysis and ECW ratio as a guidance for fluid management in critically ill patients after operation. Sci. Rep. 2021; 11(1): 12168, doi: 10.1038/s41598-021-91819-7.
15. Wu Y., Yang R., Xu J., Rusidanmu A., Zhang X., Hu J. Effects of intraoperative fluid management on postoperative outcomes after lobectomy. Ann. Thorac. Surg. 2019; 107(6): 1663–1669, doi: 10.1016/j.athoracsur.2018.12.013.
16. Mahmood A., Gosling P., Vohra R.K. Randomized clinical trial comparing the effects on renal function of hydroxyethyl starch or gelatine during aortic aneurysm surgery. Br. J. Surg. 2007; 94(4): 427–433, doi: 10.1002/bjs.5726.
17. Godet G., Lehot J.J., Janvier G., Steib A., De Castro V., Coriat P. Safety of HES 130/0.4 (Voluven(R)) in patients with preoperative renal dysfunction undergoing abdominal aortic surgery: a prospective, randomized, controlled, parallel-group multicentre trial. Eur. J. Anaesthesiol. 2008; 25(12): 986–994, doi: 10.1017/S026502150800447X.
18. Huang C.C., Kao K.C., Hsu K.H., Ko H.W., Li L.F., Hsieh M.J. et al. Effects of hydroxyethyl starch resuscitation on extravascular lung water and pulmonary permeability in sepsis-related acute respiratory

distress syndrome. Crit. Care Med. 2009; 37(6): 1948–1955, doi: 10.1097/CCM.0b013e3181a00268.
19. Wiedermann C.J., Dunzendorfer S., Gaioni L.U., Zaraca F., Joannidis M. Hyperoncotic colloids and acute kidney injury: a meta-analysis of randomized trials. Crit. Care 2010; 14(5): R191, doi: 10.1186/cc9308.
20. Schortgen F., Lacherade J.C., Bruneel F., Cattaneo I., Hemery F., Lemaire F. et al. Effects of hydroxyethylstarch and gelatin on renal function in severe sepsis: a multicentre randomised study. Lancet 2001; 357(9260): 911–916, doi: 10.1016/S0140-6736(00)04211-2.
21. Corcoran T., Rhodes J.E., Clarke S., Myles P.S., Ho K.M. Perioperative fluid management strategies in major surgery: a stratified meta-analysis. Anesth. Analg. 2012; 114(3): 640–651, doi: 10.1213/ANE.0b013e318240d6eb.
22. Giglio M., Dalfino L., Puntillo F., Rubino G., Marucci M., Brienza N. Haemodynamic goaldirected therapy in cardiac and vascular surgery: A systematic review and meta-analysis. Interact. Cardiovasc. Thorac. Surg. 2012; 15(5): 878–887, doi: 10.1093/icvts/ivs323.
23. Challand C., Struthers R., Sneyd J.R., Erasmus P.D., Mellor N., Hosie K.B. et al. Randomized controlled trial of intraoperative goaldirected fluid therapy in aerobically fit and unfit patients having major colorectal surgery. Br. J. Anaesth. 2012; 108(1): 53–62, doi: 10.1093/bja/aer273.
24. Bisgaard J., Gilsaa T., Rønholm E., Toft P. Optimising stroke volume and oxygen delivery in abdominal aortic surgery: a randomised controlled trial. Acta Anaesthesiol. Scand. 2013; 57(2): 178–188, doi: 10.1111/j.1399-6576.2012.02756.x.
25. Budacan A.M., Naidu B. Fluid management in the thoracic surgical patient: where is the balance? J. Thorac. Dis. 2019; 11(6): 2205–2207, doi: 10.21037/jtd.2019.05.75.
26. Lee E.H. Optimal fluid therapy for thoracic surgery. J. Thorac. Dis. 2019; 11(5): 1753–1755, doi: 10.21037/jtd.2019.05.15.
27. Cagini L., Capozzi R., Tassi V., Savignani C., Quintaliani G., Reboldi G. et al. Fluid and electrolyte balance after major thoracic surgery by bioimpedance and endocrine evaluation. Eur. J. Cardiothorac. Surg. 2011; 40(2): e71–e76, doi: 10.1016/j.ejcts.2011.03.030.
28. Messina G., Natale G., Fiorelli A., Puca M.A., Moscatelli F., Monda V. et al. Functional effect of adiponectin and body composition assessment in lung cancer subjects after video-assisted thoracoscopic surgery (VATS) lobectomy. Thorac. Cancer 2025; 16(2): e15260, doi: 10.1111/1759-7714.15260.