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Original Article

Reasons for staying in hospital after video-assisted thoracoscopic surgery lobectomy

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Abstract

Background: Despite implementation of enhanced recovery after surgery (ERAS) in lung surgery, potential barriers for improvements should be identified. The aim of this single-centre, prospective ERAS cohort study was to explore reasons for delayed patient discharge after video-assisted thoracoscopic surgery (VATS) lobectomy with a median length of hospital stay (LOS) of 2 days.

Methods: Consecutive patients referred for VATS lobectomy were consulted twice daily by an investigator for the primary reasons for continued hospitalization. The secondary outcomes were risk factors for delayed recovery using univariate and multivariate regression analyses.

Results: A total of 147 patients were included (69 with LOS more than 2 days and 78 with LOS of 2 days or less) from April 2020 to December 2020. Air leak (27.7 per cent), pneumonia (20.2 per cent), pain (15.3 per cent), urinary/renal factors (11.0 per cent), atrial fibrillation (7.0 per cent), respiratory failure (4.5 per cent), cognitive factors/delirium (4.3 per cent), gastrointestinal factors (3.8 per cent), oxygen dependency (2.7 per cent), social factors (2.0 per cent), and pleural effusion (1.4 per cent) were important factors for discharge more than 2 days after surgery. The 30-day readmission rate after discharge was 21 per cent for LOS of 2 days or less and 22 per cent for LOS more than 2 days ($P = 0.856$). On a multivariate regression model, age (per 5-year increase, odds ratio (OR) 1.29, 95 per cent c.i. 1.01 to 1.66, $P = 0.043$) and forced expiratory volume in 1 s (FEV_1) per cent (per 5 per cent increase, OR 0.89, 95 per cent c.i. 0.81 to 0.98, $P = 0.021$) were significantly related to discharge after more than 2 days.

Conclusion: Despite a short median LOS of 2 days, air leak, pneumonia, and pain remain the most important challenges for further improvement of the ERAS programme. Age and FEV_1 per cent were statistically significant risk factors for LOS longer than 2 days.

Introduction

Video-assisted thoracoscopic surgery (VATS) has become standard of care for pulmonary lobectomy. Advantages have been demonstrated in large cohort studies and a recent randomized clinical trial with less pain, faster return to daily activities, better shoulder function, fewer complications, better tolerance of adjuvant chemotherapy, and shorter length of stay (LOS)[1,2] in hospital. Enhanced recovery after surgery (ERAS) protocols have successfully been adopted in most surgical procedures[3] and recently, the ERAS® Society and the European Society of Thoracic Surgeons published their guidelines for lung surgery, recommending 45 items for enhancing recovery[4]. Although fewer elements may be required[5], increased compliance with an ERAS pathway has been shown to be beneficial and to reduce LOS as well as opioid use without increasing postoperative adverse events and costs[6].

Nevertheless, several challenges remain for further improvement[3,5], including an analysis of 'Why do patients stay in hospital after surgery?' as conducted for colonic and orthopaedic procedures[7,8]. However, little is known about specific reasons for similar questions after VATS lobectomy[9,10] despite adoption of an ERAS programme.

The primary aim of this prospective consecutive cohort study was to explore reasons for delayed patient discharge after VATS lobectomy following an established ERAS protocol with a median LOS of 2 days. The secondary aim was to identify other perioperative (preoperative and intraoperative) risk factors for LOS longer than 2 days.

Materials and methods

The study was reported complying with STROBE Guidelines[11].

Study design, setting, and participants

The study was approved by the Danish Regional Ethics Committee (H-20014489) and the Danish Data Protection Agency, with a single-centre, prospective, observational design. The study was preregistered with an analysis plan at www.clinicaltrials.gov (registration no. NCT04294108).

Consecutive patients scheduled for VATS lobectomy in the Department of Cardiothoracic Surgery, Copenhagen University Hospital, Rigshospitalet were recruited for the study. The standard perioperative care pathway was applied for every patient referred for pulmonary resection, containing all components of the ERAS guidelines[4,5]. All patients were

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operated by way of a standardized three-port anterior approach as previously described[12]. A multimodal opioid-sparing regimen consisting of paracetamol, ibuprofen, and gabapentin was used. A paravertebral single-shot block was applied intraoperatively by the surgeon for more than five thoracic levels with a total of 20 ml 0.5 per cent bupivacaine. At the end of surgery an intercostal catheter was inserted at the drain site with continuous bupivacaine 0.25 per cent, 6 ml/h and remained until chest drain removal[13]. Routinely, only one chest drain was applied and connected to a digital drainage system Thopaz$^+$ (Medela, Switzerland) with a standard suction of −2 cm H_2O[14]. Only adults speaking Danish were included in the study. Patients who received any other procedure than VATS lobectomy were excluded. Written informed consent was obtained from all patients.

Routinely, patients were admitted on the morning of surgery. The discharge criteria were self-mobilization, normal gastrointestinal function, chest drain and all intravenous lines removed, and no need for opioids. The criteria for chest drain removal was air leak 20 ml/min or less for more than 12 h, whereas there was no upper threshold for serous fluid unless with chyle or blood[14]. A chest X-ray was performed 2 h after chest drain removal. Another chest X-ray was performed when the patient was seen in the outpatient clinic 2 weeks after surgery. Patients with prolonged air leak are not sent home with a chest drain in this setting. All patients in this cohort were discharged to their homes. If complications occurred, they were re-admitted to the department, but complete follow-up was secured by the electronic record system in Easter Denmark.

Variables and data measurement

LOS was counted as the number of nights hospitalized after surgery. Duration of chest drainage was defined from the day of placement to the day of removal. All participants were consulted to assess reasons for staying in hospital twice daily (08:00 hours and 16:00 hours) by an investigator (L.H.) asking 'why do you stay in hospital now?' and double checking the reasons using data from the Thopaz$^+$, reviewing the medical record, and consulting with clinically responsible surgeons and nurses. R.H.P. and H.K. supervised the process, and any discrepancies were discussed together. To decrease bias, the consultation at 08:00 hours aimed not only to interactively secure factors to be collected at 16:00 hours, but also to supplement reasons occurring after 16:00 hours the day before. Each reason for non-discharge was individually assessed and analysed each day.

Air leak was defined as continuous air flow of more than 20 ml/min on the Thopaz$^+$, recurrent pneumothorax requiring another chest drain or expanding subcutaneous emphysema. Postoperative pain was considered a barrier for discharge if the patient noted this in the daily interviews. Pneumonia was defined as the need for treatment with antibiotics for a respiratory infection and at least one of the following criteria: new or changed purulent sputum; new or changed lung opacity on a clinically indicated chest X-ray; temperature greater than 38.3°C; leucocyte count greater than 12 000/μl. Atrial fibrillation was verified by an ECG. Urinary/renal factors covered all complications associated with the urinary tract, for instance urinary tract infection and renal insufficiency, diagnosed by blood sample or microbiological examination. Respiratory failure was verified by blood gas analysis. Oxygen dependency was defined as the need for oxygen therapy without symptoms of breathlessness. Cognitive factors/delirium covered any cognitive disorder and delirium, for example hallucination, forgetting appointments, and dates, forgetting recent conversations and events, and becoming more impulsive or apathetic. Gastrointestinal factors were defined as any complication associated with any symptom in the gastrointestinal system, for instance nausea, vomiting, diarrhoea, or constipation. Pleural effusion was defined as needing reinsertion of a chest drain due to pleural fluid without air leak. Other medical diagnoses as reasons for delaying discharge were adjusted in accordance with the ICD-10. Social factors were defined as any factor without association to health, for example living alone, or waiting for a home transportation.

Demographic data (age, sex, BMI, smoking, and alcohol status, activity, and living status, surgical history, and distance of living from hospital) were recorded as well as clinical parameters (percentage of forced expiratory volume in 1 s (FEV_1 per cent), FEV_1/forced vital capacity (FVC), diffusing capacity of the lung for carbon monoxide (DLCO), co-morbidity, weight loss, chronic pain, duration of surgery, blood loss, type of lobectomy, surgeon

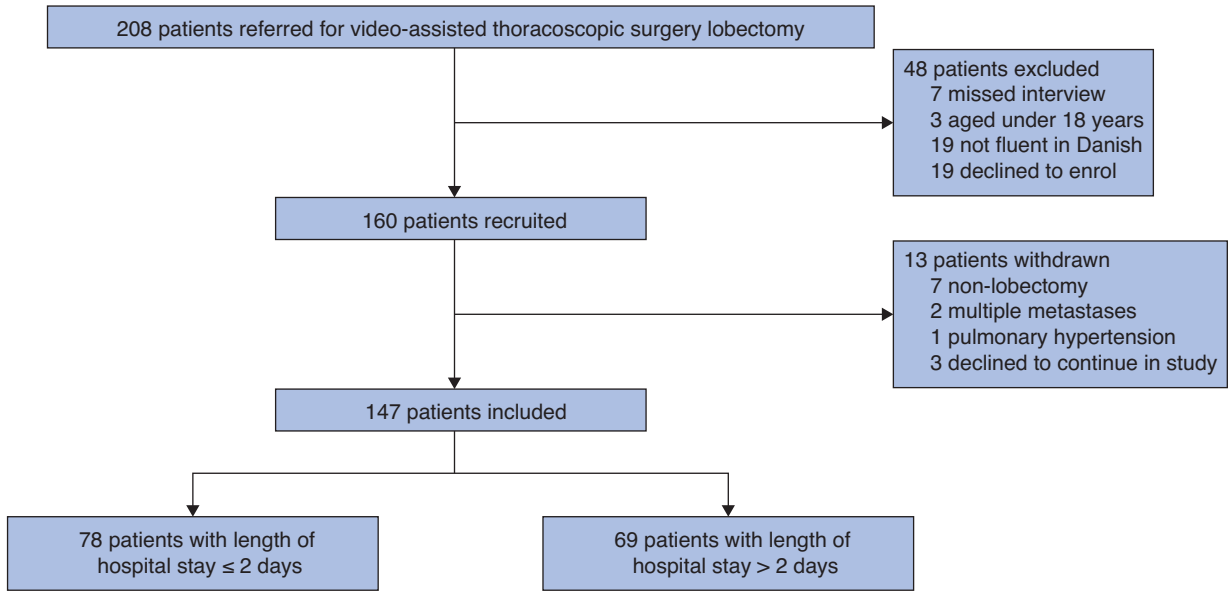

Fig. 1 Flow chart of patients enrolled and included.

Table 1 Demographics and clinical characteristics

Characteristics	Total ($n=147$)	LOS ≤2 days ($n=78$)	LOS >2 days ($n=69$)	P
Age, year*	71 (66–75)	69.5 (63–74)	73 (69–76)	0.001
Male sex†	75 (51.0)	42 (54)	33 (48)	0.511
BMI, kg/m2*	26.2 (22.6–29.0)	26.6 (22.9–29.0)	25.9 (22.4–29.1)	0.458
FEV_1%*	86.5 (73.0–103.3)	93.5 (78.0–106.3)	79.0 (68.0–95.5)	0.001
FEV_1/FVC, %*	69.0 (63.0–76.0)	71.5 (64.3–77.0)	67.5 (62.0–73.8)	0.045
DLCO, %*	73.0 (62.0–88.3)	76.0 (63.0–93.8)	71.0 (55.8–85.3)	0.055
Smoking status†				0.529
Non-smoker	23 (15.6)	14 (18)	9 (13)	
Former smoker	89 (60.5)	44 (56)	45 (65)	
Current smoker	35 (23.8)	20 (26)	15 (22)	
Alcohol status†				0.650
No and limited alcohol use	120 (81.6)	65 (83)	55 (80)	
Excess alcohol use	27 (18.4)	13 (17)	14 (20)	
Normal activity†	131 (89.1)	74 (95)	57 (83)	0.031
Live alone†	60 (40.8)	25 (32)	35 (51)	0.029
Distance of living from hospital, km*	10 (3–26)	9 (3–25)	11 (4–30)	0.264
Surgical history†	108 (73.5)	59 (76)	49 (71)	0.502
Charlson co-morbidity index*	2 (1–3)	1 (1–3)	2 (1–3)	0.501
Pulmonary co-morbidity†	43 (29.3)	19 (24)	24 (35)	0.204
Arrhythmia required treatment†	17 (11.6)	6 (8)	11 (16)	0.130
Chronic pain†	36 (24.5)	17 (22)	19 (28)	0.154
Diabetes†	16 (10.9)	7 (9)	9 (13)	0.447
Hypertension†	64 (43.5)	27 (35)	37 (54)	0.031
Weight loss†	28 (19.0)	9 (12)	19 (28)	0.024
Type of lobectomy†				0.927
Left upper lobectomy	25 (17.0)	14 (18)	11 (16)	
Left lower lobectomy	26 (17.7)	14 (18)	12 (17)	
Right upper lobectomy	47 (32.0)	23 (30)	24 (35)	
Right middle lobectomy	6 (4.1)	4 (5)	2 (3)	
Right lower lobectomy	37 (25.2)	19 (24)	18 (26)	
Bi-lobectomy	6 (4.1)	4 (5)	2 (3)	
Duration of surgery, min*	99 (83–119)	93 (81–112)	106 (88–123)	0.012
Blood loss, ml*	25 (5–50)	20 (0–50)	25 (10–95)	0.016
Ending of surgery before 12:00 hours†	73 (49.7)	40 (51)	33 (48)	0.742
Senior surgeon†	54 (36.7)	25 (32)	29 (42)	0.234

*median (interquartile range).
†frequency (proportion).
DLCO, diffusion capacity of the lung for carbon monoxide; FEV_1, forced expiratory volume in 1 s; FVC, forced vital capacity; LOS, length of hospital stay.

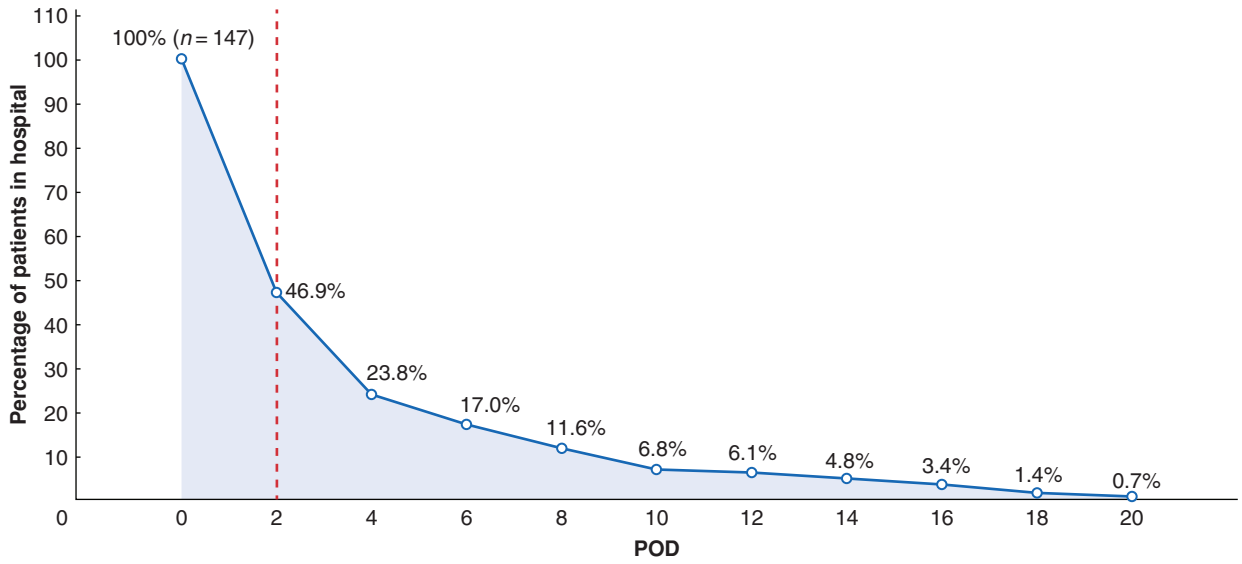

Fig. 2 The percentage of patients in hospital after video-assisted thoracoscopic surgery lobectomy.
The dotted line represents the cut-off for dividing participants into with length of hospital stay greater than 2 days or with LOS of 2 days or less. POD, postoperative day.

experience, and time point of ending surgery). Smoking status was classified as 'non-smoker', 'former smoker', and 'current smoker'. Alcohol status was classified as 'no and limited alcohol use', and 'excess alcohol use'. Excess alcohol use means more than 14 units/week for men, more than 7 units/week for women, or any patient with a history of alcohol abuse. Normal activity was defined as walking without any assistance (such as roller and wheelchair), except for a limp. Surgical history was classified as

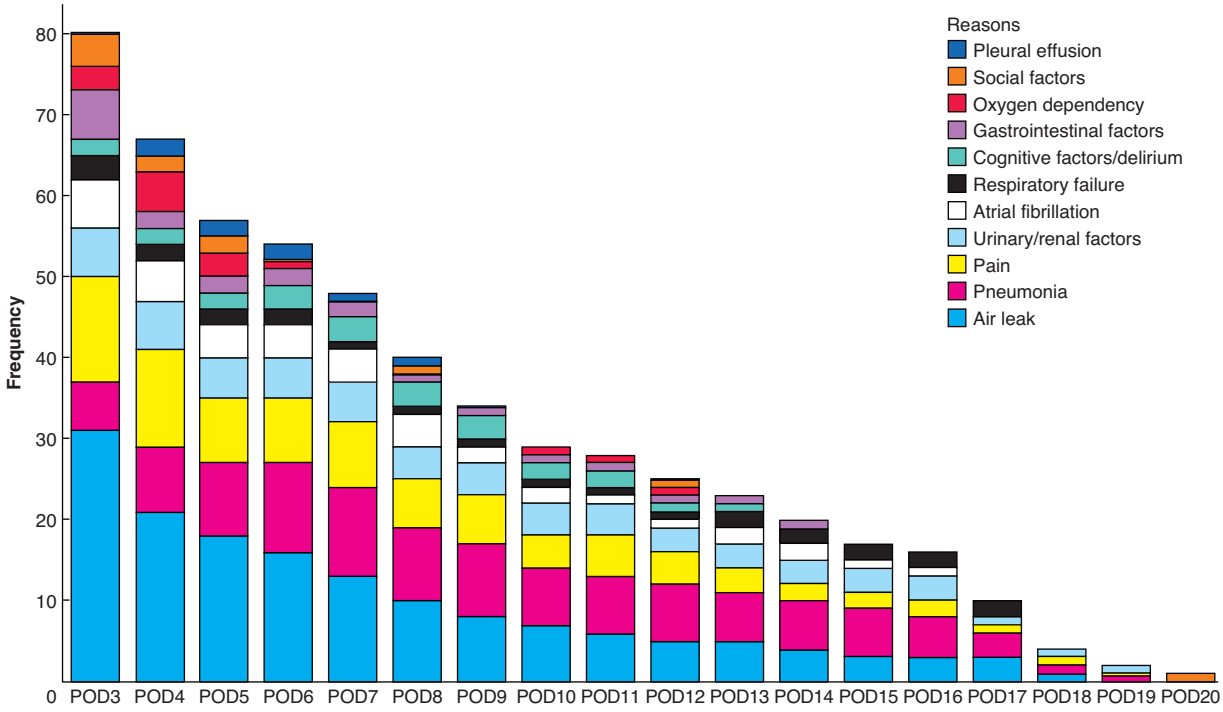

Fig. 3 Reasons for length of hospital stay greater than 2 days.
POD. postoperative day.

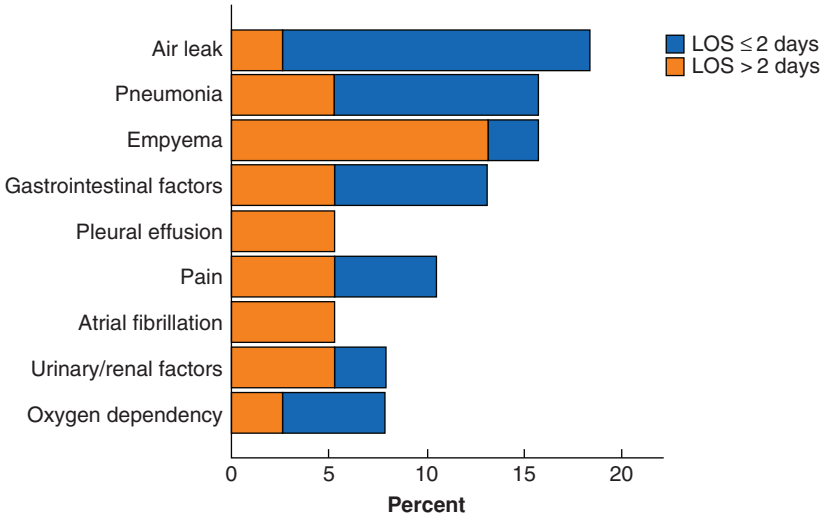

Fig. 4 The reasons for 30-day readmissions.

any invasive surgery less than 3 months before the operation. All co-morbidities were defined in accordance with ICD-10. Chronic pain was defined as ongoing pain before surgery. A senior surgeon was defined as a consultant with more than 10 years of experience. Readmission was defined as admission to any hospital within 30 days after the index discharge. All data were collected via an electronic healthcare software (Epic, Madison, Wisconsin).

Data were captured by L.H. with REDCap (Research Electronic Data Capture tool)[15].

Sample size

The power calculation was based on LOS of patients scheduled for VATS lobectomy in the department in 2019 (unpublished, $n = 340$, mean(s.d.) 4.76(5.20) days, median 3 days, percentage of LOS of 2 days or less, 45 per cent). LOS of 2 days or less was the goal for the ERAS programme. Consequently, a sample of 160 patients was estimated to be sufficient for a 90 per cent chance of detecting a difference between the goal and the non-goal groups at the 5 per cent level of significance with a two-sided Wilcoxon–Mann–Whitney *U* test (two groups) and allowing a 10 per cent non-completion rate. The calculation was made via G*Power version 3.1[16].

Statistical analysis

Continuous variables without normal distribution were identified by Kolmogorov–Smirnov and Shapiro–Wilk test and presented by median and interquartile range (i.q.r.). Categorical variables were

Table 2 Preoperative and intraoperative factors associated with length of hospital stay greater than 2 days in univariate (unadjusted) and multivariate regression analysis (adjusted)

Characteristics	Unadjusted		Adjusted	
	OR (95% c.i.)	P	OR (95% c.i.)	P
Age, per 5-year increase	1.43 (1.14–1.80)	0.002	1.29 (1.01–1.66)	0.043
Sex				
Female	Ref.			
Male	0.79 (0.41–1.50)	0.466		
BMI, per 1 kg/m^2 increase	1.00 (0.94–1.06)	0.987		
FEV_1%, per 5% increase	0.86 (0.79–0.95)	0.001	0.89 (0.81–0.98)	0.021
FEV_1/FVC, per 5% increase	0.96 (0.85–1.09)	0.521		
DLCO, per 5% increase	0.93 (0.86–1.00)	0.064	0.97 (0.89–1.06)	0.470
Smoking status				
Non-smoker	Ref.			
Former smoker	1.52 (0.60–3.86)	0.375		
Current smoker	1.26 (0.42–3.84)	0.680		
Alcohol status				
No and limited alcohol use	Ref.			
Excess alcohol use	1.27 (0.55–2.94)	0.572		
Normal activity				
No	Ref.			
Yes	0.26 (0.08–0.84)	0.024	2.06 (0.52–8.11)	0.301
Live alone				
No	Ref.			
Yes	2.18 (1.12–4.27)	0.022	1.92 (0.87–4.22)	0.107
Distance of living from hospital, per 1 km increase	1.00 (0.99–1.00)	0.950		
Surgical history				
No	Ref.			
Yes	1.27 (0.61–2.64)	0.526		
Charlson co-morbidity index, per 1 increase	1.03 (0.87–1.23)	0.722		
Pulmonary co-morbidity				
No	Ref.			
Yes	1.66 (0.81–3.39)	0.167		
Arrhythmia requiring treatment				
No	Ref.			
Yes	2.28 (0.79–6.52)	0.126		
Chronic pain				
No	Ref.			
Yes	1.36 (0.64–2.90)	0.420		
Diabetes				
No	Ref.			
Yes	1.45 (0.53–3.99)	0.467		
Hypertension				
No	Ref.			
Yes	2.18 (1.12–4.24)	0.021	1.63 (0.75–3.55)	0.221
Weight loss				
No	Ref.			
Yes	2.91 (1.22–6.97)	0.016	2.20 (0.84–5.77)	0.110
Type of lobectomy				
Bi-lobectomy	Ref.			
Left upper lobectomy	1.71 (0.27–11.06)	0.571		
Left lower lobectomy	1.57 (0.24–10.22)	0.636		
Right upper lobectomy	2.09 (0.35–2.51)	0.421		
Right middle lobectomy	1.00 (0.09–11.03)	1.000		
Right lower lobectomy	1.90 (0.31–11.64)	0.490		
Duration of surgery, per 10 min increase	0.93 (0.86–1.00)	0.064	0.97 (0.89–1.06)	0.470
Blood loss, per 10 ml increase	1.06 (0.96–1.17)	0.259		
Ending of surgery before 12:00 hours				
No	Ref.			
Yes	1.15 (0.60–2.20)	0.676		
Senior surgeon				
No	Ref.			
Yes	0.65 (0.33–1.28)	0.212		

OR, odds ratio; DLCO, diffusion capacity of the lung for carbon monoxide; FEV_1, forced expiratory volume in 1 s; FVC, forced vital capacity.

presented as frequencies (percentage). The patients were separated into one group with LOS of 2 days or less and another with LOS more than 2 days. Comparison of continuous variables was conducted with a Wilcoxon–Mann–Whitney *U* test, whereas categorical variables were compared with a Pearson chi-squared or Fisher's exact test. Independent factors of delayed discharge, as defined by $P \leq 0.1$ on univariate logistic regression analysis (unadjusted), were tested via multivariate logistic regression model (adjusted) with backward stepwise analysis. A 2.2 per cent missing data frequency in the original data set was found to be acceptable[17].

The statistical analyses were conducted with statistical software SPSS® (version 25.0, IBM, Armonk, New York, USA) and

R Software (version 4.0.3, R Foundation for Statistical Computing, Vienna, Austria). Tableau Software (version 2020.4, Salesforce, San Francisco, California, USA) was applied for data visualization. A P value <0.05 (two-sided) was considered statistically significant.

Results

From April 2020 to December 2020, 160 eligible patients who met the inclusion criteria were identified (*Fig. 1*). Of these, 10 did not receive a VATS lobectomy and 3 declined to continue participation, leaving 147 for analysis. Demographics are shown in *Table 1*. Median age was 71 (i.q.r. 66–75) years and 51.0 per cent were male. Patients with LOS of more than 2 days were older than patients with LOS of 2 days or less (median 73.0 (i.q.r. 69.0–76.0) years *versus* 69.5 (i.q.r. 63.0–74.0) years, $P = 0.001$), and had a lower FEV_1 per cent (median 79.0 (i.q.r. 68.0–95.5) *versus* 93.5 (i.q.r. 78.0–106.3), $P = 0.001$), whereas FEV_1/FVC and DLCO were not significantly lower. Smoking and alcohol status, distance of living from hospital, surgical history, and type of lobectomy were not significantly different between the two groups.

Patients with LOS of more than 2 days had a lower activity level ($P = 0.03$) and more patients in this group lived alone ($P = 0.03$), had more hypertension ($P = 0.03$), and weight loss ($P = 0.02$), but otherwise there was no difference in co-morbidity. The group with LOS of more than 2 days had longer duration of surgery (median 13 min, $P = 0.01$) and more blood loss (median 5 ml, $P = 0.02$) than patients discharged earlier. Completion of surgery before noon and surgeon experience were not different between groups ($P = 0.74$ and $P = 0.23$ respectively). In this cohort, there were three patients (2.0 per cent) needing another chest drain insertion due to pneumothorax. Additionally, three patients (2.0 per cent) underwent re-operation, all due to postoperative bleeding, and were treated with a VATS procedure.

The number and proportion of hospitalized patients are shown in *Fig. 2*. Seventy-eight patients (53.1 per cent) were discharged on or before 2 days, whereas 69 (46.9 per cent) stayed for more than 2 days. More than 75 per cent of patients were discharged within 4 days. The median LOS was 2 (i.q.r. 2–4) days, and the median duration of chest drainage was 1 (i.q.r. 1–2) day.

The distribution and time course of reasons for discharge after 2 days is shown in *Fig. 3*. The most prevalent reasons were air leak (27.7 per cent), pneumonia (20.2 per cent), and pain (15.3 per cent), whereas social reasons only accounted for 2.0 per cent, including patients awaiting home transportation. From postoperative day (POD)3 to POD19, air leak, pneumonia, postoperative pain, and urinary/renal factors remained the most common, with atrial fibrillation, and respiratory failure being additional contributing factors. The occurrence of the different reasons for LOS greater than 2 days gradually decreased from POD3, except cognitive confusion/delirium, oxygen dependency, pneumonia, and respiratory failure. The incidence of readmission within 30 days of discharge was 21 per cent ($n = 16$) in LOS of 2 days or less and 22 per cent ($n = 15$) in LOS more than 2 days ($P = 0.856$ between groups). Air leak was the most important reason for 30-day readmission (18 per cent), followed by pneumonia (16 per cent), empyema (16 per cent), gastrointestinal factors (13 per cent), and pain (11 per cent). In LOS of 2 days or less, the dominant reason of 30-day readmission was air leak, whereas empyema was dominant in LOS more than 2 days. (*Fig. 4*)

In the univariate regression analysis (*Table 2*), preoperative risk factors for a LOS greater than 2 days included a lower FEV_1 per cent, lower activity level, and living alone. In the multivariate regression model, higher age (per 5-year increase, OR 1.29, 95 per cent c.i. 1.01 to 1.66, $P = 0.043$) and lower FEV_1 per cent (per 5 per cent increase, OR 0.89, 95 per cent c.i. 0.81 to 0.98, $P = 0.021$) were associated with LOS greater than 2 days.

Discussion

Implementation of an ERAS protocol reduces LOS[18]. Even though 53.1 per cent of unselected patients undergoing VATS lobectomy within an effective ERAS programme were discharged on or before 2 days, as previously demonstrated in selected patients[19,20], the current results clearly demonstrate the challenges for further improvement in the remaining hospitalized patients. Although compliance with elements of an ERAS protocol apparently was considered high (median LOS 2 days), several somatic, organizational, and preoperative co-morbidity factors were responsible for LOS greater than 2 days. Consequently, the challenge to improve implementation and design of a future optimized ERAS protocol should focus on the undesirable pathophysiological responses and organ dysfunctions[3] as well as the overall compliance with the ERAS protocol[21,22]

Air leak was the most dominating factor for LOS greater than 2 days. To reduce air leak, numerous prediction, and interventional models have been proposed including sex, pulmonary function, weight, smoking status, surgical history, activity, surgeon expertise, operational position, and type of surgery[23,24]. Although intuitively prehabilitation seems rational, the outcomes regarding pulmonary function and complications are still debatable[25,26]. A water test with sterile water is mandatory at completion of surgery to detect and repair a potential air leak[27]. Gentle handling of the pulmonary tissue and the application of fissure-less techniques (the fissure is left untouched, and the hilar structures are divided before a complete stapling of the fissure) have been demonstrated to reduce air leak[28,29]. Application of sealants may be considered, although the evidence for the efficacy is sparse[30]. Additionally, the postoperative chest drain placement has little impact on air leak, although a low-suction programme may be helpful[14].

Despite early discharge with an effective ERAS programme being potentially beneficial[1,2,19–21], it apparently does not eliminate the recovery problem as postoperative complications may prolong LOS. Patient-reported pain was associated with prolonged LOS, and was probably related to chest drain placement. Thus, pain and chest drain placement make early mobilization more difficult, increasing the rate of hypostatic pneumonia and alveolar atelectasis. Thus, for expedited rehabilitation, multimodal opioid-sparing analgesia treatment is important, following the procedure-specific evidence[4]. Moreover, as air leak increases the incidence of pulmonary and other complications[31], the future focus should be on air leak, as well as pain, and early mobilization. The risk of respiratory failure with continuous oxygen dependency further emphasizes this problem; however, intensified mobilization may be helpful[3,32].

Cognitive confusion/delirium could also limit patient ambulation and should be possible to reduce with improved ERAS protocols[3]. Although the use of a urinary catheter is not recommended in ERAS protocols unless there is gross renal dysfunction before surgery, it needs attention with early removal and following updated evidence-based re-catheterization principles[33]. Additionally, an emphasis on care to reduce renal

morbidity (euvolemia, avoidance of non-steroidal anti-inflammatory drugs (NSAIDs) in preoperative kidney insufficiency), and gastrointestinal morbidity (such as NSAIDs *versus* COX-2 inhibitors and laxatives) should be instituted[3]. Finally, in some communities, social factors may play a more important role for delayed discharge, a topic that has been discussed from the very beginning of enhanced recovery protocols with increased patient information and to make the patients 'better before faster', thereby limiting the specific role of social factors.

In the final model, FEV_1 per cent, and age were associations for delayed discharge. The findings of a lower preoperative FEV_1, low activity level, and living alone are similar to the findings by Pompili and colleagues[9], demonstrating an increasing incidence of prolonged duration of hospital stay after VATS lobectomy; however, in that study the median length of stay was 4 days and prolonged LOS was defined as greater than 7 days. Interestingly, smoking status, distance of living from the hospital, and experience of the surgeon were not significant risk factors for prolonged LOS.

The 30-day readmission rate is rather high, and it may be speculated whether this was due to the very early discharge. However, there was no significant difference between patients discharged early or later in this study, which correlates with another recent study[34].

Despite implementation of an effective ERAS programme with a median LOS of 2 days, this study has important limitations. First, the sample size was limited, which introduces potential reporting bias into outcomes with lack of power for subgroup analysis in the longer LOS group. Second, it was a single-centre study, which limits generalizability; however, the strength of the study is the well described and effective ERAS programme, the consecutive unselected VATS lobectomy cohort (in the inclusion criteria, patients with central tumours, involvement of N1 or single N2 categories, or induction radiochemotherapy were allowed) and the complete follow-up.

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Data availability

Data are available on request from the authors.

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