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Patient reported outcome data as performance indicators in surgically treated lung cancer patients

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Highlights

- Even in a small country, large differences between subpopulations are present
- Surgical resection extent is not associated with postoperative Global Health Status
- Surgical access type is not associated with postoperative Role Function
- It is feasible to use PROs as outcome indicators after lung cancer surgery

Abstract

Objective

Quality in lung cancer care is in Denmark routinely evaluated using quality indicators. The indicators are reported from national registries and are based on data from health care professionals. However, data based on the patients' perspective are rarely reported. The aim of this study was to propose a model for the use of patient reported outcomes (PROs) as quality indicators, enabling us to compare PROs across the surgical departments in Denmark.

Methods

All patients registered in the Danish Lung Cancer Registry (DLCR) from 1 October 2013 until 30 September 2015 who received surgical treatment were eligible (N=1,718). They were asked to complete the European Organisation for Research and Treatment of Cancer (EORTC) QLQ-C30 questionnaire six months after surgery. From QLQ-C30 we chose *global health status* (GHS) and *role function* (RF) as indicators to be tested. An indicator threshold for good performance was set to ≥ 65 points (on a scale 0-100 where 100 was the best). Results were compared between the four thoracic surgical departments in Denmark.

Results

Of 1,615 patients alive six months after surgery, questionnaires were completed by 1,002 patients (62.0%). The patients from the four departments differed significantly in clinical variables at diagnosis, and the departments differed significantly in the surgical procedures performed. After adjustment for case-mix, the patients in Department 2 had a better RF than patients from the other departments.

Conclusion

Significant differences in RF and in the fulfilment of the indicator requirement for RF were observed. Since these findings might indicate differences in the quality of performance between participating departments, subsequent audit is recommended. The analyses and results indicate that it is feasible to use PROs as supplementary outcome indicators in the evaluation of the quality of surgical treatment for lung cancer. Our model could serve as a useful foundation for further research.

Keywords

Lung cancer surgery

Patient reported outcome

Performance indicator

Global Health Status

Role Function

EORTC QLQ-C30

Introduction and Background

Performance indicators are the preferred method to measure quality in health care internationally [1, 2]. Such indicators (also known as clinical indicators or quality indicators) are developed by health care professionals based on best evidence available, and they are categorised according to the aspects of health care assessed. “Mortality” is an example of an *outcome indicator*. This outcome might be influenced by multiple aspects of care, including factors related to the patient, the illness, the treatment, and the organisation with responsibility for care and treatment [3, 4].

National quality registries (also frequently named quality databases) typically contain data from health care personnel treating and taking care of the patients. Through auditing it is evaluated if the quality of care measured by the selected indicators is acceptable according to pre-specified standards [5].

Since 2000, the Danish Lung Cancer Registry (DLCR) has monitored and evaluated the quality of treatment of Danish lung cancer patients [6]. All Danish hospitals diagnosing and treating patients with lung cancer are obliged to continuously report data to DLCR, which yields a close to complete national registry. In annual reports, the treatment quality has been measured at the national, regional, and local levels [7]. What is missing in this quality measurement, however, is the patients’ perspective; there is no information in DLCR coming directly from the individual patient about wellbeing, symptoms and quality of life during or after the treatment.

The aim of this study was to test a model for the use of patient reported outcomes (PROs) as outcome indicators. Particularly, we wanted to introduce a method comparing PROs from patients receiving surgery in different surgical departments in Denmark, in line with the use of other known quality indicators. To compare differences in treatment quality, we examined the differences in patient characteristics and the types of surgical procedures chosen in the departments. In this process, we wished to examine if the choice of surgical procedures was associated with PROs and which variables to adjust for.

1. Methods

1.1. Data from the PROLUC study

We used previously collected data from The *Patient Reported Outcomes in LUngCancer* study (PROLUC), which has been described in detail elsewhere [8]. In brief, the project aimed to collect PROs from all newly diagnosed Danish patients with lung cancer through their first year after diagnosis. Data were collected in a 2-year period from 1 October 2013 to 30 September 2015. The patients were asked to complete the European Organisation for Research and Treatment of Cancer (EORTC) QLQ-C30 and QLQ-LC13 questionnaires at specific time points in relation to planned hospital follow-up visits. The questionnaires were sent to the patients by post or e-mail after a check that the patient was still alive. Patients not returning questionnaires were sent a reminder by letter after 14 days and a new questionnaire after 42 days. For this project, only data from patients who had received curatively intended surgery were used. We used the questionnaires filled out close to six months after initial treatment, within the interval 136-240 days. This interval was chosen to ensure that the patients had finished adjuvant treatment (defined in DLCR as oncological treatment within 60 days after surgery) if needed, and because, according to the national guidelines, all patients had a visit to the outpatient clinic six months after initiation of treatment. If a patient had returned more than one questionnaire during the period, the one closest to 180 days after treatment was used [8].

1.2. Choice of PRO indicators

For the test of PROs as indicators, we wanted to investigate issues of high importance to the patients. In the study by Gralla et al. [9], 660 patients with lung cancer were asked to rank 20 symptoms and quality of life issues according to importance. It was shown that *quality of life*, *maintaining independence*, and *the ability to perform normal activities* were the three most important issues to the patients. We selected the *Global Health Status* (GHS) and *Role Function* (RF) scores from the QLQ-C30 questionnaire to cover these issues. GHS measures overall health and overall quality of life during the past week (items 29 and 30), rated on a 7-point scale from "Very poor" to "Excellent". RF concerns the patients' ability to do usual daily activities, and the patient is asked if he/she has been limited in doing work and hobbies during the past week (items 6 and 7). The two RF items are rated on a 4-point scale from "Not at all" to "Very much". Scores for GHS and RF can be transformed to range between 0 and 100 as described in the EORTC QLQ-C30 Scoring Manual [10]. After transformation of scores using this method, a high score for GHS represents a high health-related QoL, and a high score for RF represents a high level of functioning. We wanted to test GHS and RF as outcome indicators, and we chose a score ≥ 65 as threshold (the indicator standard) for both measures. To be included in our study population, a patient from PROLUC had to have data for calculation of GHS as well as RF.

1.3. Data from DLCR

From DLCR we obtained data on patients' age, surgical department, surgical technique used (access to the thoracic cavity), the extent of resection, and the use of adjuvant treatment. Lung cancer stages (established post-operatively) according to the 7th edition of the Tumour, Node and Metastasis (TNM) classification were categorised *I* (Ia-Ib), *II* (IIa-IIb), and ≥ *III* (IIIa-IV). Lung cancer cell type was divided into three groups: *squamous cell carcinoma*, *adenocarcinoma*, and *other*. We also used pre-operatively collected data on patients' pulmonary function test, FEV_1 (forced expiratory volume in 1 second, measured in % of an expected value, based on standards for a healthy person of a certain age, sex and height) and the Eastern Cooperative Oncology Group (ECOG) Performance Status (PS) Scale. For this study, PS and Charlson Comorbidity Index [11] scores were each divided into three groups: *0*, *1*, and ≥ *2*. The patient population was divided into groups according to the four departments in Denmark performing the surgery.

1.4. Data from Statistics Denmark

Data on patients' socioeconomic and demographic characteristics in the year before diagnosis were obtained from Statistics Denmark, and we used the classifications described previously [8]. In short, educational level was divided into *high*, *medium* or *low*. Disposable income was divided into quartiles based on the total population with lung cancer from the PROLUC study and was classified as: *low* (first quartile), *medium* (second and third quartiles), and *high* (fourth quartile). Work market affiliation was categorised into *in work (including studying)*, *unemployed,* and *pensioner* (including early retirement). Cohabitation status in the year before diagnosis was defined as *living with a partner*, irrespective of marital status, or *living alone*.

1.5. Statistical analyses

We first compared patient characteristics and types of surgery performed in the four surgical departments, using t-test, X^2 test, and ANOVA test. Following this and by applying our indicator threshold of ≥ 65, the patients were divided into groups according to their mean scores for GHS and RF. We dichotomised PRO data as either "low" or "high" (for our logistic regression, 0 was ≤ 65, 1 was ≥ 65) and examined the characteristics of the patients with high scores.

We examined the associations between the "treatment variables" *access technique* (divided into *thoracotomy* or *video-assisted thoracoscopic surgery (VATS)*), and *extent of surgery* (divided into *wedge resection/segmentectomy* or *lobectomy/pneumonectomy*), and the achieved PRO indicators. Logistic regression was used for this analysis (and for the following as well) and we adjusted for differences in patient characteristics (including pre-operative performance status) and the need for adjuvant treatment (which is associated with cancer stage). When analysing access technique, we adjusted for extent of surgery, and vice versa.

To reveal variations in clinical practice between the surgical departments, we examined the associations between the four departments and the treatment variables, adjusted for differences in patient characteristics (including pre-operative PS) and adjuvant treatment. When analysing access technique, we adjusted for extent of surgery, and vice versa.

Our final analysis examined the associations between the surgical departments and the PRO indicators ≥ 65 after adjustment for differences in patient characteristics (including pre-operative PS), adjuvant treatment, surgical access technique, and extent of surgery.

The significance level was set at $p \leq 0.05$. All statistical analyses were made using STATA through the research servers at Statistics Denmark [12].

2. Results

Within the 2-year study period of PROLUC, 7,295 patients were registered in DLCR and received treatment for lung cancer. Of these, 1,718 (23.6%) patients received curatively intended surgery. At 180 days (six months) after surgery, 1,615 (94.0% of 1,718) patients were still alive and thus potential respondents to the questionnaires. A total of 1,019 patients responded (63.1%), and 1,002 (62.0%) of these had answered the questions for calculation of GHS as well as RF in the questionnaire, thus defining our study population.

2.1. Patient characteristics and distribution according to surgical department

The division according to surgical department resulted in four groups with 152-332 patients, as presented in Table 1. The groups differed significantly in both patient characteristics at diagnosis (cancer stage, cell type, ECOG PS, highest attained educational level, and disposable income), and the treatment variable surgical access technique used. Only differences of statistical significance are mentioned in the following.

Department 1 used VATS as the preferred surgical access technique in 89.7% of the patients, whereas the other departments used this access in 52.7-58.0% of patients ($p < 0.001$). Only 59.6% in Department 2 had stage I cancer, compared to 65.1-67.2% in the other departments ($p < 0.001$). Department 1 had 17.0% of patients with squamous cell cancer, compared to 24.6-29.6% in the other groups ($p < 0.001$). Only 56.9% of patients in Department 1 had ECOG PS = 0, compared to 61.4-69.9% in the other groups ($p < 0.001$). More patients in Department 1 had a high educational level (22.5% compared to 14.5-17.1% in the other departments, $p = 0.041$), and a high disposable income (37.6% compared to 26.8-30.9% in the other departments, $p = 0.034$).

2.2. Associations between patient characteristics and clinical variables and PRO indicators ≥ 65

Several significant associations between patient characteristics and PRO indicators were found, as presented in Table 2. High GHS was associated with no adjuvant treatment, low post-operative cancer stage, good ECOG PS, low CCI, high educational level, high disposable income, affiliation to work market (in work or studying), and cohabitation (living with a partner).

High RF was associated with low age, low post-operative cancer stage, cancer cell type, high FEV1, good ECOG PS, low CCI, high educational level, high disposable income, affiliation to work market, and cohabitation (living with a partner).

2.3. Associations between surgical access technique and extent of surgery and PRO indicators

After adjustment for differences in patient characteristics (including pre-operative PS) and adjuvant treatment, there were no significant associations between the surgical access type, or the extent of surgery performed, on either GHS or RF (see Table 3).

2.4. Associations between surgical departments and access technique and surgical departments and extent of surgery

After adjustment for differences in patient characteristics (including pre-operative PS) and adjuvant treatment, we examined differences in clinical practice between the departments (see Table 4). Department 1 was significantly more likely to perform VATS (as opposed to thoracotomy), compared to the remaining three departments. Furthermore, Department 1 was significantly more likely to perform lobectomy or pneumonectomy (as opposed to wedge resection or segmentectomy), compared to the remaining three departments.

2.5. Associations between surgical departments and PRO indicators

After adjustment for differences in patient characteristics (including pre-operative PS), adjuvant treatment, surgical access technique, and extent of surgery, we examined the associations between surgical departments and PRO indicators (see Table 5). Patients in Department 2 had a significantly higher likelihood of having a high RF compared to the other departments (OR 1.54, 95% CI: 1.05;2.25). Differences in GHS between departments were not significant.

3. Discussion

In this study we wanted to introduce a model for the use of patient reported outcomes (PROs) as outcome indicators measured and tested in Danish patients six months after receiving curatively intended surgery for lung cancer. Patient characteristics at diagnosis as well as surgical procedures performed differed significantly between the four surgical departments. This correlates well with previous reports from DLCR [7].

Achieved levels of PRO indicators were associated with many patient characteristics, e.g. cancer stage, CCI, and affiliation to work market. However, interpretation is difficult because of the effects of possible interaction between the clinical variables. An example is ECOG PS observed by the doctor before surgery, which may correlate with *role functioning* as reported by the patient. The PS can have great impact on the choice of surgery performed, e.g. if a patient appears fragile and has a low PS, the surgical procedure chosen will often be as gentle as possible.

In terms of choice of surgical procedure, there was a great difference between the departments, with particularly one of the departments having significantly more VATS procedures and lobectomies/pneumonectomies than the other departments. This pattern remained unchanged after adjustment for differences in patient characteristics and clinical variables. This confirms previous experience from the annual audits and the reports from DLCR [7].

An apparent association between a high GHS and the choice of lobectomy/pneumonectomy as surgery diminished after adjustment for potential confounders. Overall, none of the treatment variables analysed were significantly associated with the PRO outcome indicators.

The finding that patients from one particular department exhibited significantly higher odds for a high RF compared to patients from other departments remained significant after adjustment for relevant confounders as well as other variables available. Thus, this finding cannot be explained from the data available in this study. A following audit may clarify reasons for this difference in indicator results.

Outcome indicators provide a broader perspective as opposed to e.g. process indicators measuring single activities or episodes in patient care [3]. A disadvantage of outcome indicators is that they can be difficult to interpret, given the many factors influencing the result. In case of a poor result, one single explanation and solution is therefore rarely an option; however, sometimes the combination of outcomes data and process data can provide a possible explanation. Because we have data from the whole EORTC QLQ-C30 questionnaire we know of many of the patients' symptoms and their physical and psychical wellbeing besides the indicators chosen in this study. Should a surgical department wish to clarify reasons for a specific indicator result, it would be possible to look at data from this particular department. If e.g. a satisfactory indicator threshold was not achieved, an overview of the whole questionnaire could generate solutions as to improve quality in care and treatment.

The GHS and RF were chosen for our test of PROs as indicators because we wanted to use issues of high importance to the patients. In theory we could have tested any (or all) items from the EORTC QLQ-C30, or we could have used the total summary score. However, the true purpose of the study was not to test specific scores, rather it was to propose a method for the use of PROs as outcome indicators.

The threshold score of 65 for both GHS and RF was chosen based on similar studies using EORTC QLQ-C30 six months after patients had surgery for lung cancer [13-17]. The threshold could hypothetically be any number between 0 and 100, and we could have used the mean or median value for all of our responding patients; however, as seen in Table 3, this was also close to 65. Again, the aim of the study was not to determine a “gold standard” threshold, but rather to test the feasibility of using PROs as performance indicators.

With the disease burden and comorbidity often seen in patients with lung cancer in mind, we find the response rate above 60% acceptable for testing the indicator. However, as was proposed in the PROLUC study [8], initiatives can be made to further raise response rates, e.g. implementation of PRO collection as a routine part of every contact to the hospital, shortening of the questionnaire, or designing the questionnaire as an app for use in tablets or smartphones.

The PROLUC study found that among patients with lung cancer, the responders to the questionnaires had a significantly better health status compared to the non-responders [8]. We would expect the same pattern to be found in this subpopulation, and in future studies as well, as it is obvious that patients in better health have more energy to participate in questionnaire research.

In this study we introduced a model for the use of PROs as outcome indicators measured six months after surgery for lung cancer. PROs *before* surgery were not used in the analyses, and it is a limitation of this study that no adjustment for baseline PROs was made. As described in the paper about the PROLUC study [8], baseline data were available for less than 20% of the surgically treated patients, and we therefore did not find it reasonable to use these data. If better data had been available, it would have been possible to use "*change from baseline*" as an indicator, which could possibly have been a more accurate measure of the effect of the treatment on PROs. Whether or not absolute score thresholds (as in our example) or indicators based on change from baseline (which is an entirely different concept) are most useful as outcome indicators is unknown. In future studies, it could be interesting to test this. The method introduced here could easily be transferred to a study describing change in PROs and the two approaches could be applied in parallel and results compared.

4. Conclusion

In this model for the use of PROs as quality indicators after surgery for lung cancer, we compared surgical departments in Denmark. Despite the small size of our country, large differences were found in patient characteristics and types of surgical procedures performed. After adjustment for possible confounders, a significant difference between surgical departments in the odds of having a high level on Role Functioning, one of our quality indicators, was found, whereas no difference was seen for the other, Global Health Status. This difference might indicate differences in the quality of performance between participating departments, and subsequent audit is recommended. The analyses and results indicate that it is feasible and potentially relevant to use Patient Reported Outcome data as outcome indicators describing quality of surgical treatment for lung cancer. Further research is needed, and this model is a promising foundation for future work and analyses.

Conflict of interest statement

The authors declare no conflict of interest.

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Table 1. Patient characteristics in the total study population and according to surgical departments.

Table 2. Univariate associations between patient characteristics and clinical variables and PRO indicators using logistic regression.

Table 3. Associations between surgical access technique and extent of surgery and PRO indicators using logistic regression after adjustment for patient characteristics and adjuvant treatment.

Table 4. Associations between surgical department and surgical access technique and surgical department and extent of surgery using logistic regression after adjustment for patient characteristics (including pre-operative performance status) and adjuvant treatment.

Table 5. The associations between surgical departments and PRO indicators using logistic regression after adjustment for patient characteristics (including pre-operative performance status), adjuvant treatment, surgical access technique, and extent of surgery.

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Table 1. Patient characteristics in the total study population and according to surgical departments.

	Total		Department 1		Department 2		Department 3		Department 4		
	N =	%	N =	%	N =	%	N =	%	N =	%	*p* value¤
Total	**1,002**	**100**	**311**	**31.0**	**332**	**33.1**	**207**	**20.7**	**152**	**15.2**	
Sex											0.574
Male	474	47.3	140	45.0	154	46.4	105	50.7	75	49.3	
Female	528	52.7	171	55.0	178	53.6	102	49.3	77	50.7	
Age											0.601
≤ 69	550	54.9	170	54.7	177	53.3	122	58.9	81	53.3	
≥ 70	452	45.1	141	45.3	155	46.7	85	41.1	71	46.7	
Range			26-89		17-87		34-91		27-85		
Access technique											< 0.001
Thoracotomy	341	34.0	32	10.3	157	47.3	87	42.0	65	42.8	
VATS¤¤	661	66.0	279	89.7	175	52.7	120	58.0	87	57.2	
Extent of surgery											0.268
Wedge resection / Segmentectomy	150	15.0	37	11.9	53	16.0	37	17.9	23	15.1	
Lobectomy / Pneumonectomy	852	85.0	274	88.1	279	84.0	170	82.1	129	84.9	
Adjuvant treatment											0.138
No	808	80.6	250	80.4	257	77.4	170	82.1	131	86.2	
Yes	194	19.4	61	19.6	75	22.6	37	17.9	21	13.8	
Stage											< 0.001
I	645	64.4	209	67.2	198	59.6	139	67.2	99	65.1	
II	193	19.3	54	17.4	62	18.7	42	20.3	35	23.0	
≥ III	139	13.9	48	15.4	54	16.3	20	9.7	17	11.2	
Not applicable¤¤¤	25	2.5	-	-	-	-	-	-	-	-	
Cell type											< 0.001
Squamous cell	245	24.5	53	17.0	96	28.9	51	24.6	45	29.6	
Adenocarcinoma	553	55.2	186	59.8	180	54.2	101	48.8	86	56.6	
Other	204	20.4	72	23.2	56	16.9	55	26.6	21	13.8	
FEV1, median											0.103
% of expected	83.2		80.1		83.2		84.9		82.4		
Not reported	191	19.1	100		55		23		13		
ECOG Performance Status											< 0.001
0	633	63.2	177	56.	232	69.	127	61.	97	63.	

				9		9		4		8	
1	242	24.2	77	24.8	60	18.1	58	28.0	47	30.9	
≥ 2	27	2.7	10	3.2	4	1.2	6	2.9	7	4.6	
Not reported¤¤¤	100	10.0	-	-	-	-	-	-	-	-	
Charlson Comorbidity Index											0.682
0	464	46.3	148	47.6	152	45.8	99	47.8	65	42.8	
1	202	20.2	54	17.4	67	20.2	46	22.2	35	23.0	
≥ 2	336	33.5	109	35.1	113	34.0	62	30.0	52	34.2	
Highest attained educational level											0.041
High	178	17.8	70	22.5	52	15.7	30	14.5	26	17.1	
Medium	762	76.0	227	73.0	248	74.7	169	81.6	118	77.6	
Short	29	2.9	7	2.3	14	4.2	4	1.9	4	2.6	
Not applicable	33	3.3	7	2.3	18	5.4	4	1.9	4	2.6	
Disposable income											0.034
High	310	30.9	117	37.6	89	26.8	57	27.5	47	30.9	
Medium	474	47.3	135	43.4	168	50.6	108	52.2	63	41.5	
Low	199	19.9	55	17.7	65	19.6	40	19.3	39	25.7	
Not applicable¤¤¤	19	1.9	-	-	-	-	-	-	-	-	
Affiliation to work market											0.444
In work/studying	197	19.7	63	20.3	69	20.8	41	19.8	24	15.8	
Pensioner	761	75.9	229	73.6	249	75.0	160	77.3	123	80.9	
Unemployed	44	4.4	19	6.1	14	4.2	6	2.9	5	3.3	
Cohabitation											0.124
Living w. partner	682	68.1	204	65.6	218	65.7	154	74.4	106	69.7	
Living alone	320	31.9	107	34.4	114	34.3	53	25.6	46	30.3	

¤ The p-value is a X^2 test of the variables below each caption in bold lettering, comparing the departments with each other. Significance level: $p < 0.05$.
¤¤ VATS: Video-Assisted Thoracoscopic Surgery
¤¤¤ Division of patients for this table caused some subgroups to be very small (≤ 3 patients for certain groups) and to keep patient data anonymous according to Danish legislation, some data in the table have been concealed.

Table 2. Univariate associations between patient characteristics and clinical variables and PRO indicators using logistic regression.

	High GHS¤			High RF¤		
	Proportion of patients %	OR	95% CI	Proportion of patients %	OR	95% CI
Sex						
Male	62.7	1.00		69.2	1.00	
Female	64.2	1.07	[0.83;1.38]	70.3	1.05	[0.80;1.38]
Age						
≤ 69	63.5	1.00		74.0	1.00	
≥ 70	63.5	1.00	[0.77;1.30]	64.6	0.64	[0.49;0.84]
Access technique						
Thoracotomy	60.7	1.00		67.7		
VATS¤¤	64.9	1.20	[0.91;1.57]	70.8	1.15	[0.87;1.53]
Extent of surgery						
Wedge resection / Segmentectomy	56.7	1.00		67.3	1.00	
Lobectomy / Pneumonectomy	64.7	1.40	[0.98;1.99]	70.2	1.14	[0.79;1.66]
Adjuvant treatment						
No	65.5	1.00		71.0	1.00	
Yes	55.2	0.65	[0.47;0.89]	64.4	0.74	[0.53;1.03]
Stage (post-operatively)						
I	67.4	1.00		74.0	1.00	
II	59.6	0.71	[0.51;0.99]	65.8	0.68	[0.48;0.96]
≥ III	52.5	0.53	[0.37;0.77]	55.4	0.44	[0.30;0.64]
Not applicable	52.0	0.52	[0.23;1.17]	72.0	0.91	[0.37;2.21]
Cell type						
Squamous cell carcinoma	60.8	1.00		63.3	1.00	
Adenocarcinoma	64.7	1.18	[0.87;1.61]	73.4	1.60	[1.16;2.21]
Other	63.2	1.11	[0.76;1.63]	67.7	1.21	[0.82;1.80]
Lung function, FEV1						
< Median (< 83.2)	62.8	1.00		64.0	1.00	
≥ Median	66.2	1.16	[0.87;1.54]	75.6	1.74	[1.28;2.35]
Not reported	59.2	0.86	[0.60;1.22]	69.6	1.29	[0.89;1.86]
ECOG Performance Status						
0	68.4	1.00		74.4	1.00	
1	56.6	0.60	[0.44;0.81]	59.9	0.51	[0.38;0.70]
≥ 2	37.0	0.27	[0.12;0.60]	40.7	0.23	[0.11;0.52]
Not reported	56.0	0.59	[0.38;0.90]	72.0	0.88	[0.55;1.42]
Charlson Comorbidity Index						
0	68.1	1.00		74.8	1.00	
1	60.9	0.73	[0.52;1.03]	66.8	0.68	[0.47;0.97]
≥ 2	58.6	0.66	[0.50;0.89]	64.6	0.61	[0.45;0.84]
Highest attained educational level						
High	68.0	1.00		77.5	1.00	
Medium	63.7	0.82	[0.58;1.17]	68.9	0.64	[0.44;0.94]
Short	44.8	0.38	[0.17;0.85]	55.2	0.36	[0.16;0.80]
Not applicable	51.5	0.50	[0.24;1.06]	60.6	0.45	[0.20;0.97]
Disposable income						
High	71.6	1.00		79.4	1.00	

Medium	61.6	0.64	[0.47;0.87]	66.5	0.52	[0.37;0.72]
Low	55.3	0.49	[0.34;0.71]	62.3	0.43	[0.29;0.64]
Not applicable	63.2	0.68	[0.26;1.78]	73.7	0.73	[0.25;2.10]
Affiliation to work market						
In work or studying	67.0	1.00		77.2	1.00	
Pensioner	63.5	0.86	[0.61;1.19]	68.3	0.64	[0.44;0.92]
Unemployed	47.7	0.45	[0.23;0.87]	61.4	0.47	[0.24;0.94]
Cohabitation						
Living with partner	66.3	1.00		71.7	1.00	
Living alone	57.5	0.69	[0.52;0.90]	65.6	0.75	[0.57;1.00]

¤ *High GHS: GHS ≥ 65. High RF ≥ 65. Both are measured on a scale ranging 0-100.*
¤¤ *VATS: Video-Assisted Thoracoscopic Surgery*

Table 3. Associations between surgical access technique and extent of surgery and PRO indicators using logistic regression after adjustment for patient characteristics and adjuvant treatment.

	High GHS¤			High RF¤		
	Proportion of patients %	**OR**	**C.I.**	**Proportion of patients %**	**OR**	**C.I.**
Access technique						
Thoracotomy	60.7	1.00		67.7	1.00	
VATS¤¤	64.9	1.18	[0.88;1.57]	70.8	1.09	[0.81;1.48]
Extent of surgery						
Wedge resection / segmentectomy	56.7	1.00		67.3	1.00	
Lobectomy / pneumonectomy	64.7	1.31	[0.89;1.92]	70.2	1.06	[0.71;1.59]

Adjusted for sex, age group, adjuvant treatment, stage, cell type, FEV1, PS, CCI, educational level, disposable income, affiliation to work market, cohabitation and extent of surgery or surgical access technique.
¤ *High GHS: GHS ≥ 65. High RF ≥ 65. Both on a scale 0-100.*
¤¤ *VATS: Video-Assisted Thoracoscopic Surgery*

Table 4. Associations between surgical department and surgical access technique and surgical department and extent of surgery using logistic regression after adjustment for patient characteristics (including pre-operative performance status) and adjuvant treatment.

Department	Surgical access technique thoracotomy vs. VATS¤		Extent of surgery wedge resection vs. lobectomy / pneumonectomy	
	OR	**C.I.**	**OR**	**C.I.**
1 (reference)	1.00		1.00	
2	0.12	[0.07;0.18]	0.59	[0.35;0.98]
3	0.13	[0.08;0.21]	0.39	[0.23;0.67]
4	0.12	[0.07;0.21]	0.44	[0.24;0.81]

Adjusted for patient characteristics including PS, adjuvant treatment, and extent of surgery or surgical access technique
¤ *VATS: Video-Assisted Thoracoscopic Surgery*

Table 5. The associations between surgical departments and PRO indicators using logistic regression after adjustment for patient characteristics (including pre-operative performance status), adjuvant treatment, surgical access technique, and extent of surgery.

Department	High GHS¤			High RF¤		
	Proportion of patients %	OR	C.I.	Proportion of patients %	OR	C.I.
1	62.7	1.00		68.5	1.00	
2	65.4	1.35	[0.94;1.93]	72.9	1.54	[1.05;2.25]
3	62.8	1.05	[0.71;1.56]	72.5	1.32	[0.87;2.01]
4	61.8	0.98	[0.63;1.52]	61.8	0.85	[0.55;1.32]

Adjusted for patient characteristics (including PS),adjuvant treatment, surgical access technique, and extent of surgery.
¤ *High GHS: GHS ≥ 65. High RF ≥ 65. Both on a scale 0-100.*