



End-of-life cost for lung cancer patients in Greece: a hospital-based retrospective study

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Objective: The aim of the present study was to estimate the cost of treating patients with lung cancer at their end-of-life (EOL) phase of care in Greece. **Materials & methods:** A hospital-based retrospective study was conducted in the Oncology Unit of 'Sotiria' Hospital, in Athens, Greece. All lung cancer patients who died between 1 January 2015 and 31 December 2018 with at least 6 months follow-up were enrolled in the study. Healthcare resource utilization data, including inpatient and outpatient ones, during the last 6 months before death was extracted from a registry kept in the unit. This data were combined with the corresponding local unit costs to calculate the 6, 3 and 1-month EOL cost in €2019 values. **Results:** A total of 122 patients met the inclusion criteria. The mean (standard deviation) age at diagnosis was 67.8 (8.9) years with 78.7% of patients being male and 55.0% diagnosed at stage IV. About 52.5% of patients had been diagnosed with adenocarcinoma, 28.7% with squamous non-small-cell lung cancer types and 18.9% with small-cell-lung cancer. The median overall survival of these patients was 10.8 months. During the EOL periods, the mean cost/patient in the last 6, 3 and 1 month were €7665, €3351 and €1009, respectively. Pharmaceutical cost was the key driver of the total cost (75% of the total 6-month) followed by radiation therapy (16.2%). The median EOL 6-month cost was marginally statistically significantly higher among patients with adenocarcinoma (€9031) compared with squamous (€6606) and to small-cell-lung cancer (€5474). **Conclusion:** The findings of the present study indicate that lung cancer treatment incurs high costs in Greece, mainly attributed to pharmaceutical expenses, even at the EOL phase.

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Keywords: end-of-life care cost • Greece • lung cancer • retrospective study

Lung cancer is a major public health problem worldwide, the most recent global estimations indicate that 2.1 million new cases were diagnosed worldwide in 2018, with 1.8 million death in the same year [1]. Greece is one of the European countries in which lung cancer is a leading cause of death with almost 8300 people having died from lung cancer in 2018 [1]. Apart from the humanistic burden, lung cancer may incur great economic consequences for the healthcare systems, patients and society overall. More specifically, the direct cost of care for lung cancer patients amounts to more than €3 billion per year in Europe [2], while after considering costs related to disability and premature mortality, as well, the total cost amount to more than €100 billion [2]. Moreover, in Greece, a nationwide study that calculated annual hospital costs for the treatment of smoking-attributable diseases, demonstrated that lung cancer-related costs for that year were approximately €38.2 million [3].

However, cancer care costs vary by clinical care phase, with the highest costs observed in the initial period following diagnosis and in the last year of life (end-of-life [EOL] period) [4–7]. The increased EOL care cost is attributed to the aggressive cancer care over the past decade [8]. There is a growing body of literature revealing the overuse of chemotherapy, radiotherapy and monoclonal antibodies/immunotherapy during the last weeks of death [9–11] especially in advanced stage cancer patients [9–11] with limited data to be available for lung cancer

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patients [9]. Moreover, the existing literature declare that the EOL care depends on a wide range of characteristics such as patients' age, sex and other sociodemographic characteristics, cancer type and geographical location [11]. However, more aggressive medical care is associated with not only increased cost but worst patients' quality of life, as well [12–14]. Therefore, estimating EOL care cost and how it varies depending on patient characteristics is critical for healthcare policy makers in order to guide effective interventions for minimizing the impact of EOL care on both patients and society. In Greece, limited data are available regarding the EOL cost of lung cancer patients [15]. In this retrospective study, although the total EOL cost and its cost components are presented, no data are provided regarding the factors that might affect this. In this context, the objective of the current study was to estimate the EOL care cost for patients with lung cancer in Greece and to identify patient characteristics that might affect this cost.

Materials & methods

Study design & population

A retrospective study was conducted based on data extracted from a hospital-based registry kept in the Oncology Unit of 'Sotiria' Hospital, in Athens, Greece with all new lung cancer cases who took care in this unit from 2015 onwards. The population of the present study consisted of patients diagnosed with non-small-cell lung cancer, specifically adenocarcinoma and squamous, or small-cell-lung cancer (SCLC) and died between 1 January 2015 and 31 December 2018, with at least 6 months of follow-up before death occurred. All patients died in this time interval were accounted, irrespectively of the place of death. The information maintained in this cancer registry was extracted from patients' medical records.

Data collected

For the purposes of the present study the following data were extracted: patients' demographic characteristics such as gender and age and lifestyle characteristics such as smoking status at the time of diagnosis (i.e., current, former or nonsmoker). Moreover, cancer related characteristics at the time of diagnosis like the histological type, the stage and the performance status were also extracted. As for staging, the 7th edition of TNM classification for patients diagnosed earlier than 1 January 2017 was used, while for those with a diagnosis after the mentioned date, 8th edition was used. Patients were classified into those diagnosed at an early stage (stage I or II), those diagnosed at locally advanced (stage III) and metastatic stage (stage IV).

Healthcare resource utilization data, such as hospitalization, therapy (i.e., chemotherapy/immunotherapy, radiotherapy and surgery), and laboratory/imaging tests during the last 6 months before death were also extracted. More specifically, the data extracted regarding medication therapy (i.e., chemotherapy, targeted therapy, immunotherapy, supportive therapy like zoledronic acid, denosumab, granulocyte colony-stimulating factors (G-CSFs) and erythropoietin) included the name of the active substance, the total dose per administration, the route of administration, the number of days of administrations per cycle, and the number of cycles per line. Hospitalization data included the reason of hospitalization, and the duration of hospitalization, while the type of surgery (if any) was recorded, as well. The type of radiotherapy along with the number of fractions were recorded, and the number of laboratory and imaging tests to which patients were subjected were recorded. Finally, the date of diagnosis along with the date of death was used to estimate the overall survival.

Cost estimation

To estimate EOL care cost from payer perspective, healthcare resource utilization data were combined with the corresponding local unit costs (in €, 2019), as reimbursed by the public payer (National Organization for Healthcare Services Provision [EOPYY]). To be more specific, to estimate systematic therapy cost and the supportive care cost during the EOL period, the total dose per regimen per cycle was combined with the reimbursed unit costs and the number of cycles per line of therapy administered during the last 6 months. The cost of administration of intravenous agents was included to the cost of drug therapy; this cost was extracted from the Official Government Gazette, law 2150/B/2011. The reimbursed drug cost was calculated on the grounds of the ex-factory prices, as they were published in the drug bulletin issued by the Greek Ministry of Health [16] after applying the relevant discounts provided in the corresponding legislation (Official Government Gazette, law 115/7 August 2017). The type of radiotherapy along with the number of fractions and the corresponding unit costs as extracted from the official website of EOPYY was used to estimate the radiotherapy cost. Similarly, the laboratory/imaging cost was calculated, combining the frequency of laboratory/imaging tests used during the EOL period with the corresponding unit

costs as obtained from the official website of EOPYY under the assumption that all tests were performed privately (Supplementary Table 1). The cost for inpatient services including hospitalization for reasons relevant to the disease setting as well as surgeries was calculated using the corresponding Diagnostic Related Groups tariff issued by the Greek Ministry of Health [17] (Supplementary Table 2). Similarly, the 3 and 1-month EOL was calculated, as well.

Statistical analysis

All continuous variables were summarized with median, 1st and 3rd quartiles as their distributions were skewed, while all categorical variables were summarized with frequencies (n) and percentages (%).

Cost data are presented as mean and 95% CI using the bias-corrected and accelerated CI (adjusted for ties) as obtained from 5000 nonparametric bootstrapped resamples. To determine factors associated with EOL cost we applied generalized linear models with gamma family and a log link function, which best fit the expenditure data according to the Box-Cox test and the modified Park test [18]. Cost data were additionally checked if they fit the gamma distribution using Villaseñor and Gonzalez-Estrada parameter estimators [19]. Robust standard errors were computed to account for the fact that clinicians treating patients in the same hospital may share the same clinical practices. Gamma co-efficients generated by the regression model were exponentiated to retransform them into relative cost estimates. As potential risk factors the number of comorbidities, the number of metastases, the histological type, the duration from diagnosis to death, the cancer stage, the gender and the age during diagnosis were tested using univariate models. Factors which had a p-value < 0.2 in the univariate analyses were included in the multivariate model. The significance level was set to $\alpha = 0.05$. Statistical analysis was performed using STATA software (version 13.0, STATA Corp, College Station, TX, USA) while gamma distribution fitness was checked using R version 3.6.1.

Results

Patients' characteristics

A total of 122 patients met the inclusion criteria, almost half of whom were diagnosed with adenocarcinoma. The place of death was reported for the 44% of the patients. Among them, the 59% had died in a hospital, while the rest in their home. The mean age at diagnosis was 68 years with 78.7% of patients being male and 55.0% diagnosed at stage IV. Only 9.0% of patients had no comorbidities, while more than 50.0% were current smokers at the time of cancer diagnosis. Almost all patients except for two had metastases at the time of diagnosis (Table 1). The median (1st–3rd quartile) overall survival of these patients was 10.8 (8–13) months. Almost 60.0% had died within 12 months since diagnosis.

Resource utilization

Table 2 presents the resource utilization during the EOL periods. During the last 6 months before death, 88.5% of patients received medication therapy, while this percentage reduced to 74.6% at 3 months and 41% at 1 month before death. Almost two-third of patients that received medication therapy over the last 6 months of their life, received only chemotherapy while almost 20% of drug treated patients received immunotherapy even the last month before death. Platinum-based therapies were the most frequently prescribed treatment as first-line therapy (~75% of those received chemotherapy as first-line), and nivolumab was the most frequently prescribed immunotherapy as second-line treatment (data not shown). Moreover, during the last 6 months of patients' life, more than a third was subjected to radiotherapy, while this figure was estimated to be about 10% the last month before death. Only 16% of patients were hospitalized for reason other than drug administration during the last 6 months before death, with this percentage falling to 3% in the last month of patient life. Patients required hospitalization mainly due to respiratory system disorders (in 60% of patients during the last 6 months of life; data not shown).

Cost estimations

The mean total cost per patient from payer perspective were €7665, €3351 and €1009 in the last 6, 3 and 1 month before death, respectively. Pharmaceutical cost was the key driver of the total 6, 3 and 1-month EOL cost (75, 65 and 58%, respectively) followed by radiation therapy (16.2, 22.8 and 31.1%, respectively; Table 3). The key drivers for the 6, 3 and 1-month pharmaceutical cost were the cost of G-CSFs (31, 28 and 30%, respectively), the immunotherapy cost (25, 30 and 32%, respectively) and the chemotherapy cost (23, 20 and 20%, respectively).

The 6-month EOL cost was found to be statistically significantly higher among patients diagnosed with adenocarcinoma compared with those diagnosed with squamous and SCLC, while 1-month EOL was found to be

Table 1. Demographic and diagnostic characteristics of lung cancer decedents in Greece.

Demographic and diagnostic characteristics	n = 122
Gender, n (%)	
– Female	26 (21.3)
– Male	96 (78.7)
Age at the time of diagnosis, years	
– Median (1st, 3rd quartile)	68.2 (63.7, 74.3)
Smoking status, n (%)	
– Current smoker	60 (51.3)
– Former smoker	51 (43.6)
– Nonsmoker	6 (5.1)
Histological or cytological diagnosis	
– Adenocarcinoma	64 (52.5)
– Squamous	35 (28.7)
– Small-cell-lung cancer	23 (18.9)
Stage of cancer at diagnosis, n (%)	
– Early disease (stages I & II)	9 (7.4)
– III	45 (37.6)
– IV	66 (55.0)
Number of comorbidities, n (%)	
– 0	11 (9.02)
– 1	28 (22.95)
– 2	36 (29.51)
– ≥ 3	47 (38.52)
Performance status at baseline, n (%)	
– Normal activity	23 (29.5)
– Restricted but light work	36 (46.2)
– Selfcaring. Unable to work. Mobile $>50\%$ working hours	16 (20.5)
– Limited self-care only. Mobile $<50\%$ working hours	3 (3.9)
Smoking status data were missing for four patients; stage data were missing for one patient, performance status at baseline data were missing for 44 patients.	

statistically significantly different only between patients diagnosed with adenocarcinoma and those diagnosed with squamous (Figure 1). Moreover, patients who were from 75 to 85 years old incurred statistically significantly less expenditures during last 6 months of their life compared with those who were from 65 to 75 years old ($p = .0014$) or younger than 65 years ($p = .0036$, Table 4).

The multiple generalized linear model in which patients' gender, postdiagnosis survival, number of metastases at the time of diagnosis, age, stage and histological type were entered as independent factors, revealed that the 6-month EOL cost was almost 51% higher in males compared with females ($p = 0.004$) after controlling the rest of independent variables. Moreover, a 10-year increase in patients' age at diagnosis was found to be associated with an almost 16% lower cost ($p = 0.020$), and patients diagnosed with SCLC were found to be associated with a 32% lower cost compared with those diagnosed with adenocarcinoma ($p = 0.023$). The time from diagnosis since death, the number of metastases and the stage of cancer during diagnosis were not associated with the 6-month EOL cost (Table 5). A model that included patients' gender, number of metastases at the time of diagnosis, age and histological type as independent factors, revealed that a unit increase in the number of metastases was associated with almost 15% higher 3-month EOL cost ($p = 0.047$), while the rest independent factors were not associated with the 3-month EOL (data not shown). The 1-month EOL cost was not associated with any of the variables tested, as such a multivariate model was not constructed (data not shown).

Discussion

Considering the impact of EOL care on patients' quality of life and national expenditures, the objective of the present retrospective analysis was to assess the EOL care for lung cancer patients in Greece and to estimate the EOL

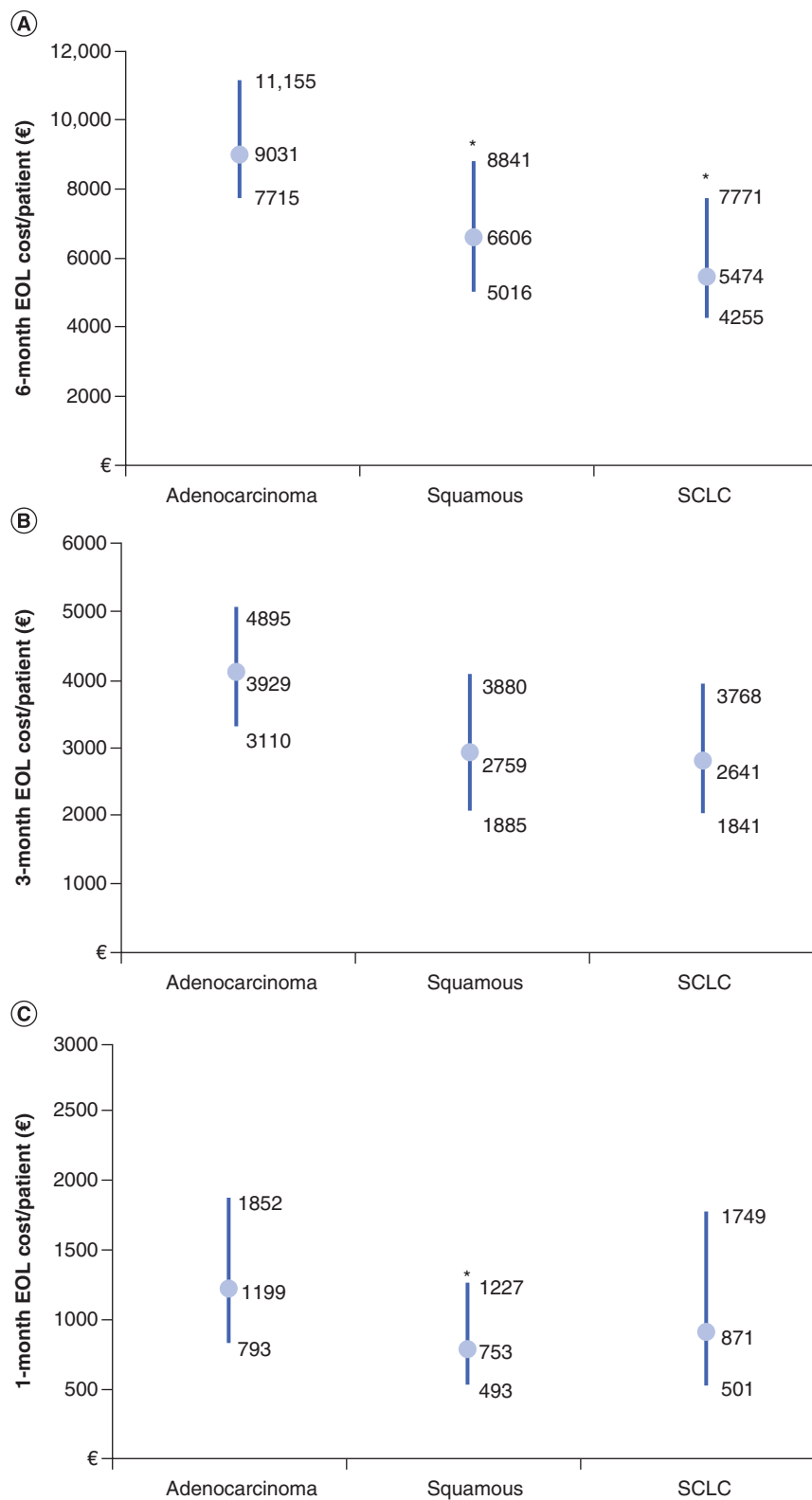


Figure 1. (A) Six, (B) 3 and (C) 1-month EOL cost per lung cancer patient by histological type, in Greece.

* $p < 0.05$ compared with adenocarcinoma.

EOL: End-of-life; SCLC: Small-cell-lung cancer.

Table 2. Resource utilization during the end-of-life periods among lung cancer patients, in Greece.

	6-months before death	3-months before death	1-month before death
Resource utilization	N (%)	N (%)	N (%)
Drug therapy	108 (88.5)	91 (74.6)	50 (41.0)
– Chemotherapy + immunotherapy + targeted therapy	2 (1.8)	0 (0.0)	0 (0.0)
– Chemotherapy + immunotherapy	18 (16.7)	8 (8.7)	1 (2.0)
– Chemotherapy	70 (64.8)	60 (65.9)	34 (68.0)
– Chemotherapy + targeted therapy	11 (10.2)	9 (9.9)	2 (4.0)
– Immunotherapy	3 (2.8)	10 (11.0)	9 (18.0)
– Targeted therapy	4 (3.7)	4 (4.4)	4 (8.0)
– G-CSF	81 (75.0)	53 (75.0)	26 (52.0)
– Epoetin	32 (29.6)	19 (20.9)	7 (14.0)
– Supportive care (other than above)	8 (7.4)	5 (5.5)	1 (2.0)
Radiotherapy	42 (34.4)	24 (19.7)	12 (9.8)
– Prior to radiotherapy, n (%) patients received			
– G-CSF	19 (45.2)	3 (12.5)	1 (8.3)
– Epoetin	10 (23.8)	2 (8.3)	0 (0)
– Supportive care (other than above)	1 (2.4)	0 (0)	0 (0)
Surgery	2 (1.6)	0 (0)	0 (0)
Hospitalization	20 (16.4)	17 (13.9)	4 (3.3)
Laboratory/imaging tests	121 (99.2)	119 (97.5)	80 (65.6)

G-CSF: Granulocyte colony stimulating factor.

Table 3. End-of-life cost (in €, 2019) for lung cancer patients in Greece.

Cost components	6-month Mean (95% CI)	3-month Mean (95% CI)	1-month Mean (95% CI)
Overall cost per patient	7665 (6733–8943)	3351 (2860–4080)	1009 (757–1428)
Cost of therapy			
– Drug therapy	5727 (4878–6853)	2170 (1821–2652)	586 (443–817)
– Chemotherapy	1306 (1050–1713)	437 (338–592)	119 (79–188)
– Targeted therapy	881 (480–1589)	339 (170–691)	63 (22–138)
– Immunotherapy	1426 (907–2352)	644 (401–1028)	190 (96–386)
– Administration	248 (210–282)	101 (82–121)	30 (23–38)
– Epoetin	71 (50–107)	34 (20–55)	9 (4–18)
– G-CSF	1777 (1458–2153)	609 (453–760)	174 (120–247)
– Supportive care (other than above)	18 (7–37)	6 (2–15)	1 (0–4)
– Radiotherapy	1244 (815–1750)	763 (457–1268)	314 (129–664)
– Surgery	55 (0–138)	0 (0–0)	0 (0–0)
Laboratory/imaging tests	330 (298–368)	170 (146–205)	66 (48–100)
Hospitalizations	309 (178–507)	247 (135–434)	43 (8–193)

G-CSF: Granulocyte colony stimulating factor.

cost. To the best of our knowledge, this is the second study in Greece [15] aiming to estimate the EOL cost for lung cancer patients and one of the few studies that have been conducted internationally [20–22]. In our study, patients died from 2015 onwards were included as opposed to the previously conducted study in Greece, in which patients died between July 2014 and February 2015 were included. As such, the present study covers the new, innovative therapies approved recently for the management of lung cancer.

Our findings declare that a large proportion of lung cancer patients in Greece continue to receive pharmaceutical therapy (i.e., chemotherapy, targeted therapy and immunotherapy) till the end of their life. Chemotherapy was the most administered therapy till the last month before death, but almost one to five patients received immunotherapy even the last month of their life. These results are in line with those presented in the previously conducted study in

Table 4. End-of-life cost (in €, 2019) stratified by lung cancer patients' characteristics in Greece.

Overall cost per patient	6-month Mean (95% CI)	3-month Mean (95% CI)	1-month Mean (95% CI)
Gender			
– Male	8001 (6672–9450)	3473 (2823–4230)	1006 (763–1474)
– Female	6426 (5092–8629)	2899 (2122–4286)	1019 (537–2262)
Age group			
– Less than 65 years	8715 (6780–11,551)	3918 (2917–5295)	1184 (666–2184)
– 65 to 75 years	8366 (6687–9703)	3790 (2938–4618)	1240 (905–1800)
– 75 to 85 years	4838 (3718–7221) [†]	1701 (1143–2980) [†]	309 (166–538) [‡]
By year			
– Up to 2016	5614 (4256–7542)	2655 (1892–3,687)	701 (470–955)
– 2017	8076 (6526–10,054)	3364 (2446–4,339)	862 (561–1489)
– 2018	8494 (6777–10,627)	3768 (2,857–4,865)	1360 (848–2151)
Comorbidities			
– 0 or 1	8366 (6496–10,478)	3825 (2754–5072)	1091 (687–1786)
– 2 or more	7336 (6056–8710)	3128 (2488–3854)	970 (642–1424)
Smoking status			
– Current smoker	7868 (6615–9531)	3697 (2916–4670)	1017 (674–1526)
– Former smoker	7827 (6155–10,103)	3135 (2397–4127)	990 (643–1721)
– No smoker	7063 (5022–9206)	2622 (1359–4058)	215 (51–700)
Stage during diagnosis			
– I or II	6013 (4285–7691)	2948 (1312–5626)	1965 (89–5427)
– III	7140 (5406–8891)	3087 (2224–3930)	940 (643–1452)
– IV	8384 (6951–10,232)	3618 (2791–4537)	923 (614–1372)
Time of death since diagnosis			
– 6–12 months	8431 (6968–10,189)	3569 (2822–4334)	1002 (673–1480)
– >12 months	6524 (5115–8085)	3025 (2222–3997)	1019 (647–1758)
[†] 6 and 3-month EOL cost differed for patients from 75 to 85 years old compared with 65 to 75 years old or younger than 65 years ($p < 0.005$ for all pairwise comparisons; Dunn's Test). [‡] 1-month EOL cost differed for patients from 75 to 85 years old compared with 65 to 75 years old ($p = 0.0012$). The other two pairwise comparisons had a p -value < 0.10 (Dunn's Test). EOL: End-of-life.			

Greece aiming to examine the EOL care cost of patients who suffered from terminal stage IIIB/IV lung cancer [15] during the last 6 months of their life. This study revealed that the main inpatient and outpatient cost drivers were chemotherapy and concomitant medication, respectively [15].

However, in other studies conducted in the USA [20,21], Canada [20], English [22] and France [23], it has been found that hospitalization cost was the main cost component of the EOL phase followed by pharmaceutical one. In some studies, it was found that hospitalization cost accounts for more than 70% of the total cost incurred during the terminal phase. These differences among the available studies could be attributed to the treatment patterns, healthcare system, unit costs, type of analysis and study design.

The increased use of pharmacotherapies during the EOL period might be partially explained by the lack of specific treatment guidelines for this phase along with patients' request to receive further therapy, although they are informed that the expected improvement in terms of survival or quality of life will be probably minimal [24]. Given that the usage of aggressive treatment at EOL stage results in higher healthcare costs without implying improved health outcomes and quality of life for patients [13], health policy interventions are needed to control the unnecessarily aggressive treatment of patients nearing death. Into this line, reduction of unnecessary pharmacotherapy use for patients with advanced cancer who are unlikely to benefit is a goal of the American Society for Clinical Oncology's Choosing Wisely Campaign [12].

Our study presented that the mean cost per patient from public payer perspective in the last 6, 3 and 1 month before death, was estimated to be €7665, €3351 and €1009, respectively. Therefore, it is understood that, the cost of EOL care has a tremendous financial impact on Greek healthcare system. More specifically, lung cancer is a

Table 5. Determinants of 6-month end-of-life cost of care for lung cancer patients in Greece: results from the multiple generalized linear model.

	Multivariate model		
	Exp(b)	95% CI	p-value
Time from diagnosis to death, months			
– >6 and ≤ 12 months	Ref		
– >12 months	0.838	0.614, 1.145	0.268
Number of metastases	1.068	0.961, 1.187	0.220
Age at diagnosis	0.981	0.967, 0.997	0.020
Gender			
– Female	Ref		
– Male	1.505	1.143, 1.981	0.004
Stage			
– I or II	Ref		
– III	1.179	0.745, 1.864	0.482
– IV	1.175	0.738, 1.873	0.497
Histology or cytology type			
– Adenocarcinoma	Ref		
– SCLC	0.677	0.483, 0.949	0.023
– Squamous	0.735	0.501, 1.077	0.114

Bold font indicates statistical significance.
SCLC: Small-cell-lung cancer; Ref: reference category.

leading cause of death in Greece with almost 8300 deaths in 2018 [1], combining this number of deaths with the EOL care cost per patient reported in present study, the estimated 1- and 6-month EOL direct cost of these patients for the Greek health system range from €8 million to €64 million per year, respectively. Consequently, it becomes clear that it is of paramount importance to consider the appropriateness of aggressive treatments for EOL patients in Greece to reduce the humanistic and economic burden on patients, their families and the health system.

Moreover, our study found that male gender, younger age and adenocarcinoma were associated with increased EOL care cost. These findings are in line with those provided in the international literature [6,20,25,26]. The association of EOL care cost with age could be partially explained by the tendency of physicians to use all treatment options to prolong the survival of a young patient. The increased EOL care cost for patients diagnosed with adenocarcinoma compared with those diagnosed with SCLC may arise from the fact that there is a growing number of new innovative therapies like immunotherapies approved for the management of non-small-cell lung cancer.

The results of the present study should be interpreted considering several limitations. The main study limitation is that this analysis is based on data extracted from a hospital-based registry and not a national population-based registry. This means that this data might come from a nonrepresentative sample of lung cancer patients in Greece. Second, only direct medical costs were considered in our analysis and not costs incurred by reduced productivity of patients/caregivers, transportation or other intangible costs. Third, although the data were extracted from a registry, the outpatient resource utilization data as well as hospitalization data were collected through interviews with patients or caregivers during the planned visits. This means that outpatient and hospitalization EOL cost is subject to self-reported bias and might hence be underestimated.

Conclusion

To sum up, the findings of the present study indicate that lung cancer treatment incurs high costs in Greece even at the EOL phase, and these costs are mainly attributed to pharmaceutical expenses. Our findings may provide useful insight into the design and implementation of interventions aiming to raise clinicians' awareness about the importance of not providing aggressive EOL to high-risk care lung cancer patients, in Greece.

Supplementary data

To view the supplementary data that accompany this paper please visit the journal website at: www.futuremedicine.com/doi/suppl/10.2217/cer-2020-0167

Summary points

- The objective of the current study was to estimate the end-of-life (EOL) care cost for patients with lung cancer in Greece and to identify patient characteristics that might affect this cost.
- A hospital-based retrospective study was conducted in the Oncology Unit of 'Sotiria' Hospital, in Athens, Greece.
- Healthcare resource utilization data, including inpatient and outpatient ones, during the last 6 months before death was extracted from a registry kept in the unit.
- During the EOL periods, the mean cost/patient in the last 6, 3 and 1 month were €7665, €3351 and €1009, respectively.
- Pharmaceutical cost was the key driver of the total cost (75% of the total 6-month) followed by radiation therapy (16.2%).
- The present study indicate that lung cancer treatment incurs high costs in Greece even at the EOL phase, and these costs are mainly attributed to pharmaceutical expenses.
- Moreover, our findings may provide useful insight into the design and implementation of interventions aiming to raise clinicians' awareness about the importance of not providing aggressive EOL to high-risk care lung cancer patients, in Greece.

Author contributions

G Kourlaba designed and supervised the study. G Kourlaba and G Stefanou conducted the analyses, interpreted the results and wrote the manuscript. E Kokkotou, E Ntalakou, A Apostolopoulou, A Charpidou and N Syrigos were the medical experts who provided local resource utilization data, contributed to results interpretation and manuscript writing. G Gourzoulidis contributed to results interpretation and manuscript writing. All authors reviewed and approved the final manuscript.

Financial & competing interests disclosure

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No writing assistance was utilized in the production of this manuscript.

Ethical conduct of research

The authors state that they have obtained appropriate institutional review board approval or have followed the principles outlined in the Declaration of Helsinki for all human or animal experimental investigations. In addition, for investigations involving human subjects, informed consent has been obtained from the participants involved.

Data sharing statement

All data used to conduct this study are included in this published article.

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