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Research Article

Interventions on Costs and Survival Rates of Lung Cancer Patients

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Abstract

Lung cancer is characterized by the uncontrolled growth of cells in the lung tissue, particularly in the lining of the respiratory tract. The disease has a high and alarming mortality rate, requiring prompt and appropriate management. This study aims to examine the costs and one-year survival rates of lung cancer patients at Dharmais Cancer Hospital. Data analysis was conducted in four stages: a retrospective observational study using secondary data from medical records, which described patient characteristics and factors affecting survival and treatment costs; analysis of survival curves by cancer stage and intervention; and testing differences in survival curves using the log-rank test. The results show that higher survival rates are often inversely proportional to shorter survival times, and vice versa. Stage 1 patients exhibited the most extended survival despite low survival rates for inpatients (48 months, 25%) and outpatients (53 months, 15%). Intervention types 4.00 (chemotherapy and radiotherapy) and 7.00 (chemotherapy, radiotherapy, and surgery) effectively extended survival, although associated survival rates remained low. The highest inpatient treatment costs were observed in stage 2 patients, while the highest annual outpatient costs were linked to surgical interventions, highlighting the difference between per-episode and cumulative annual expenditures.

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INTRODUCTION

Lung cancer constitutes a major global health crisis, contributing to over one million deaths annually[1]. The disease's impact is particularly pronounced in Indonesia, where the 2022 Global Burden of Cancer Study by the World Health Organization (WHO) identified it as the most commonly diagnosed cancer, ranking first among men (15.4%) and second overall (9.5%), while simultaneously being the leading cause of cancer-related mortality[2]. Compounding this severity, the average five-year life expectancy for lung cancer patients remains critically low at only 17.8%[3].

The immense health burden is mirrored by the financial strain associated with cancer management. In Indonesia, cancer treatment ranks second in overall catastrophic health expenditures, accounting for 18% of the total, which highlights its profound economic impact driven by high incidence, prevalence, and mortality rates[4,5]. Managing the complex and costly spectrum of medical interventions, therapies, and medications required for cancer care presents significant challenges for both patients and healthcare systems. The availability of financial resources heavily influences access to and the quality of overall care. In the Indonesian context, the Indonesia Case-Based Groups (INA-CBGs) system governs cancer management by categorizing cases based on factors such as cancer type, stage, and treatment modalities (including surgery, chemotherapy, and radiation); however, crucial disparities exist, as not all chemotherapy drugs are fully covered under the National Health Insurance (BPJS)[6,7].

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Despite notable advances in lung cancer management, overall survival rates have shown only marginal improvement, primarily because the majority of patients are diagnosed at an advanced metastatic stage[8]. The prognosis is strongly tied to the disease stage, though most cases are detected late. Beyond stage, key prognostic factors include performance status, sex, histopathological type, age at diagnosis (especially when surgical intervention is precluded), and anemia[9]. Measuring treatment success often involves survival analysis, where the Kaplan-Meier method is utilized to estimate survival functions. The Log-Rank test assesses differences between survival curves, and Cox proportional hazards regression identifies combinations of factors that influence survival time[10]. Previous studies in Indonesia have yielded mixed results regarding these prognostic factors. For instance, Supartono and Suryanto[11] found that stage IIIA, a Karnofsky score greater than 70, the absence of pleural effusion, and pre-treatment albumin levels greater than 3.5 g/dL were significantly associated with better survival in advanced-stage lung cancer. Conversely, a study by Megasari and Bagiada[12] reported no significant difference in one-year survival rates based on sex, age, stage, histopathological type, or comorbidities at Sanglah General Hospital. Furthermore, Khaksar *et al*.[13] utilized Cox regression to demonstrate significant effects from specific cell types and performance status at the 90% confidence level, while other variables, such as treatment type, age, and disease duration, were not found to be significant predictors of survival time.

Given the critical need for localized data to inform policy, this study aims to rigorously analyze the treatment costs and one-year survival outcomes of lung cancer patients at Dharmais Cancer Hospital. The findings aim to provide essential baseline data for evaluating patient prognosis and supporting evidence-based intervention strategies in lung cancer management at this specialized institution. This research is directly aligned with the Indonesian government's priority programs to enhance cancer services, particularly for lung cancer, where advanced-stage diagnoses are most frequently observed at Dharmais Cancer Hospital.

MATERIALS AND METHODS

Materials

Ethical approval for this study was secured from the Dharmais Cancer Hospital (Ethical Clearance No. 166/KEPK/VII/2022). This research exclusively utilized secondary data sourced from the Medical Records Department of Dharmais Cancer Hospital, covering the period between 2020 and 2021. The complete dataset comprised 205 patients with lung cancer, categorized into 71 inpatients and 134 outpatients. At the time of data collection, the inpatient group consisted of 32 patients who had died and 39 who survived, while the outpatient group included 57 deceased and 77 surviving patients. The research variables used in the analysis are defined in **Table I**. The analysis of direct medical cost components for stage I to stage IV cancer inpatients encompassed essential expenditures, including medication costs (therapeutic and other drugs) and medical procedure costs (chemotherapy, radiotherapy, and surgery). Additional costs incorporated into the analysis included administrative fees, doctor consultations, hospitalization charges, and laboratory services.

Table I. Research variables and coding for survival analysis.

Variable	Variable Name	Type	Description and Coding
T	Survival Time	Continuous	Duration of patient follow-up (in months).
δ	Event Indicator	Binary	Status at the end of follow-up: 0 = Patient was alive 1 = Patient had died
X_1	Cancer Stage	Categorical/Ordinal	Clinical staging of the cancer: 1 = Stage I 2 = Stage II 3 = Stage III 4 = Stage IV
X_2	Treatment/Intervention	Categorical	Type of primary therapeutic intervention received: 1 = Chemotherapy only 2 = Radiotherapy only 3 = Surgery only 4 = Chemotherapy and Radiotherapy 5 = Chemotherapy and Surgery 6 = Radiotherapy and Surgery 7 = Chemotherapy, Radiotherapy, and Surgery

Methods

Study design and grouping

This study employed a retrospective observational design utilizing secondary data from patient medical records. Patients were systematically grouped based on several sociodemographic and clinical characteristics, including medical record number, age, and gender. Key clinical parameters analyzed included Length of Stay (LOS) analysis, which spans the entire period from the patient's first examination to the completion of their treatment, lung cancer stage, and the specific interventions and therapies administered.

Data analysis

The data analysis procedure was executed in three sequential stages[14]. First, the study involved describing the characteristics of lung cancer patients, identifying factors potentially affecting patient survival, and analyzing associated treatment costs. Second, survival curves were constructed based on both cancer stage and the type of intervention received, utilizing the Kaplan-Meier method in IBM SPSS Statistics version 25. Survival time (T) was rigorously defined as the duration, measured in months, from the date of lung cancer diagnosis to the date of death or the last recorded follow-up visit. Third, differences between the survival curves for distinct patient groups were formally tested using the log-rank test[15]. Statistical significance for all comparisons was established at a p-value of <0.05.

RESULTS AND DISCUSSION

A total of 205 lung cancer patients receiving treatment at Dharmais Cancer Hospital were included in this study. As detailed in **Table II**, the patient cohort exhibited a marked disparity in sex distribution, with a majority being male (70%, n=143) compared to female patients (30%, n=62). This finding aligns consistently with both local research, such as the study conducted by Alfarisa *et al.*[16] at Dr. M. Djamil Central General Hospital, which reported a male predominance of 71.3%, and global data from the World Health Organization (WHO)[17]. This trend is further supported by international burden reports, which highlight that Asia significantly contributes to the global lung cancer incidence, with Indonesia specifically reporting a higher number of cases in men[1]. The underlying cause is often attributed to external risk factors, most notably the higher prevalence of smoking among men[18].

Table II. Respondent characteristics.

Characteristic	Category	Total Patients (n=205)	Survived	Deceased
Sex	Female	62 (30.2%)	41 (66.1%)	21 (33.9%)
	Male	143 (69.8%)	82 (57.3%)	61 (42.7%)
Age (years)	≤60	136 (66.3%)	75 (55.1%)	61 (44.9%)
	>60	69 (33.7%)	41 (59.4%)	28 (40.6%)
Type of Care	Outpatient	134 (65.4%)	77 (57.5%)	57 (42.5%)
	Inpatient	71 (34.6%)	39 (54.9%)	32 (45.1%)

The majority of patients (66%, n=136) were aged <60 years, falling primarily within the 20–60 age range. This finding is consistent with earlier local research reporting that the vast majority (95.4%) of lung cancer respondents were over 40 years old[16]. While a Turkish study by Önal *et al.*[19] reported that 71.8% of patients were aged 60 years or older at diagnosis, highlighting an older cohort in some regions, the overall trend is linked to the accumulation of damage from prolonged exposure to environmental and household carcinogenic substances, with the highest risk manifesting after age 40[20]. Additionally, age-related decline in immune function, particularly in adaptive immunity, contributes to increased cancer risk in older adults[21]. Regarding the care setting, the cohort was predominantly managed as outpatients (66%, n = 134), with 34% (n = 71) requiring hospitalization. Factors such as acute disease exacerbations, low activities of daily living (ADL) scores, hypoalbuminemia, and severe comorbid conditions like febrile neutropenia commonly necessitate inpatient care[22-24].

The analysis of chemotherapy regimens, categorized into monotherapy and combinations of two, three, or four drugs (**Table III**), revealed that combination therapy was the overwhelmingly preferred approach. Specifically, combinations of alkylating agents and antimetabolites were the most frequently utilized category, accounting for 59% of all cases. The single most common regimen was the combination of cisplatin and pemetrexed, an established first-line, platinum-based

chemotherapy protocol[25]. The regimens observed are mainly consistent with contemporary treatment guidelines for advanced-stage (Stage IV) lung cancer[26]. Among the single agents used, Paclitaxel was the most common, valued for its antimicrotubule mechanism and efficacy against various tumor types, including those resistant to anthracyclines[27]. In advanced NSCLC, the combination of pemetrexed with cisplatin is a standard treatment, offering a median overall survival of approximately 12 months, and has proven to be both safe and effective for both first-line and maintenance therapy[28,29]. The rationale for combination chemotherapy is to overcome drug resistance and enhance cytotoxicity by simultaneously targeting multiple cellular mechanisms that regulate proliferation and differentiation, which is often superior to single-agent therapy in most cancers[30]. The selection of these regimens adheres to the platinum-based therapy standard for first-line treatment, chosen for its favorable efficacy and response rate in lung cancer.

Table III. Chemotherapy regimens in lung cancer patients.

Regimen Class	Regimen Name (Drug Components)	Frequency (F)	Percentage (%)
Monotherapy			
Alkaloid Taxane	Docetaxel	1	0.42
	Paclitaxel	8	3.35
Antimetabolite	Bleomycin	6	2.51
Anthracycline	Doxorubicin	2	0.84
2-Drug Combination Regimens			
Platinum + Antimetabolite	Carboplatin + Gemcitabine	13	5.44
	Carboplatin + Pemetrexed	36	15.06
	Cisplatin + Gemcitabine	24	10.04
	Cisplatin + Pemetrexed	68	28.45
Platinum + Topoisomerase Inhibitor	Carboplatin + Etoposide	8	3.35
Platinum + Alkaloid Taxane	Carboplatin + Docetaxel	8	3.35
	Carboplatin + Paclitaxel	14	5.86
	Cisplatin + Paclitaxel	10	4.18
Antimetabolite + Alkaloid Taxane	Gemcitabine + Vinorelbine	1	0.42
3-Drug Combination Regimens			
Platinum + Anthracycline + Alkylating Agent	Cisplatin + Cyclophosphamide + Doxorubicin	2	0.84
Platinum + Taxane + Antimetabolite	Carboplatin + Docetaxel + Pemetrexed	9	3.77
	Cisplatin + Gemcitabine + Paclitaxel	4	1.67
Platinum + 2 Antimetabolites	Bleomycin + Carboplatin + Pemetrexed	9	3.77
Complex 3-Drug	Carboplatin + Cisplatin + Etoposide	1	0.42
4-Drug Combination Regimens			
Complex Combination	Bleomycin + Dacarbazine + Doxorubicin + Vincristine	12	5.02
Total Regimens		**239**	**100.00**

The direct medical costs for hospitalized lung cancer patients encompassed a range of expenses, including therapeutic and non-therapeutic medication costs, as well as procedural expenses for chemotherapy, radiotherapy, and surgery. Additional costs covered administrative fees, physician consultations, inpatient room charges, and laboratory services. As demonstrated in **Table IV**, among all cancer stages, Stage 2 incurred the highest average total inpatient cost, amounting to IDR 22,289,041 ± 27,003,395 per patient, followed closely by Stage 1. This high cost in earlier stages is primarily influenced by the costs associated with surgical procedures.

Table IV. Inpatient costs by cancer stage in lung cancer patients.

Cost Component	Total Cost (IDR) and Patient Count per Stage			
	Stage 1 (n=17)	**Stage 2 (n=18)**	**Stage 3 (n=15)**	**Stage 4 (n=21)**
	Total Cost	**Mean ± SD**	**Total Cost**	**Mean ± SD**
Chemotherapy drug costs	318,599,588	4,192,100 ± 2,538,141	52,125,204	668,272 ± 206,885
Other medication costs	358,200,427	4,713,164 ± 9,727,535	21,839,697	279,996 ± 348,954
Laboratory costs	217,696,536	2,864,428 ± 2,375,958	18,898,209	242,285 ± 170,494
Administrative costs	1,900,000	25,000 ± 0	1,950,000	25,000 ± 0
Consultation and physician fees	16,942,811	222,932 ± 143,067	15,615,883	200,204 ± 184,000
Room accommodation	646,128,210	8,501,687 ± 5,648,996	86,449,536	1,108,327 ± 1,636,498
Non-surgical costs	145,795,902	1,918,367 ± 1,510,354	22,769,695	291,919 ± 540,800
Surgical costs	55,929,211	735,911 ± 2,124,375	1,325,860,667	16,998,214 ± 5,408,000
Radiotherapy	238,976,887	3,144,433 ± 3,284,529	47,861,246	613,606 ± 237,918
Grand Total Cost	**2,000,169,572**	**21,878,267 ± 22,617,111**	**1,593,370,137**	**22,289,041 ± 27,003,395**

The components of direct medical costs for outpatients included medication costs (such as chemotherapy or other drugs), therapy administration, and physician consultation fees. Among the three main therapeutic strategies (surgery, radiotherapy, and chemotherapy), radiotherapy was the most common single intervention, utilized by 55 patients. As shown in **Table V**, while surgery incurred the highest average cost per episode (IDR 9,311,515 + 1,041,330), radiotherapy generated the highest total annual cost (IDR 807,217,199). This distinction highlights that the total cost is primarily driven by the frequency of the intervention rather than the individual episode cost, suggesting a high volume of patients receiving radiotherapy.

Table V. Average episode costs for lung cancer outpatients.

Intervention	Number of Patients	Episodes / Frequency	Cost Range (IDR)	Total Annual Cost (IDR)	Average Episode Cost (IDR)
Chemotherapy	50	68	175.000 – 9.367.831	181.277.557	2.705.635 ± 3.319.876
Radiotherapy	55	83	1.483.799 - 9.986.870	807.217.199	8.457.537 ± 1.321.968
Surgery	6	8	8.575.000 -10.916.581	74.492.119	9.311.515 ± 1.041.330
Chemotherapy and Radiotherapy	18	21	251.000 – 9.541.031	87.782.914	4.180.138 ± 3.370.289
Chemotherapy and Surgery	3	9	401.000 -9.355.163	18.723.373	2.674.767 ± 3.304.662
Radiotherapy and Surgery	3	2	4,420,864 - 8.575.000	12.995.864	6.497.932 ± 2.937.417

The Kaplan-Meier survival analysis was employed to assess the relationship between cancer stage and survival outcomes for both inpatients (**Figure 1**) and outpatients (**Figure 2**). Among inpatients, those with Stage 1 lung cancer exhibited the most extended overall survival (up to 48 months), despite a relatively low survival rate (25%). In contrast, Stage 2 and Stage 3 inpatients exhibited the highest initial survival rates (100%) within the first year; however, survival rates dropped sharply thereafter. Stage 4 inpatients had a 20% survival rate, with a maximum survival of 45 months. Similarly, among outpatients, Stage 1 patients had the most extended survival (53 months) but a low survival rate (15%), while Stage 2 and Stage 3 patients showed a 100% survival rate. The Log-rank test (**Table VI**) revealed no statistically significant differences in mean survival times across different cancer stages for both inpatients ($p = 0.342$) and outpatients ($p = 0.602$).

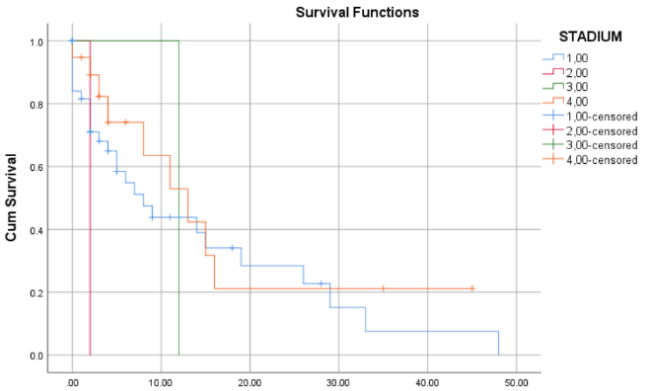

Figure 1. Kaplan-Meier survival curve: association between cancer stage and survival in lung cancer inpatients.

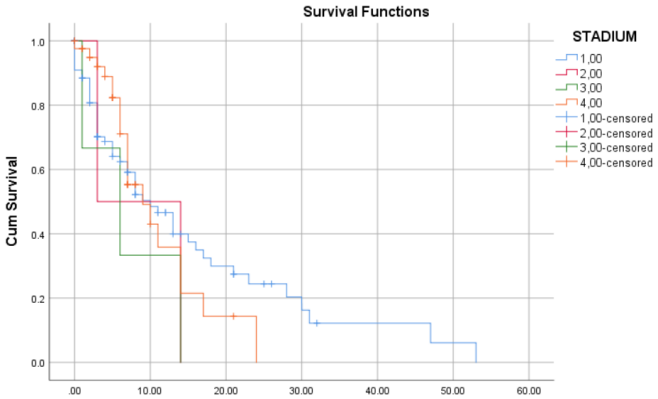

Figure 2. Kaplan-Meier survival curve: association between cancer stage and survival in lung cancer outpatients.

Table VI. Log-rank test for the association between cancer stage and survival among lung cancer inpatients and outpatients.

Category	Chi-Square	df	Sig.
Log-rank (Mantel-Cox)			
Inpatient	3.343	3	0.342
Outpatient	1.861	3	0.602

These findings suggest that while cancer staging remains a key determinant of prognosis, other confounding factors related to tumor biology, aggressiveness, and patient general health status may influence short-term survival. The overall pattern, where patients with Stage I disease, regardless of treatment setting, had the most extended survival, is consistent with the principle that early detection improves long-term outcomes[31]. However, the finding of low survival rates for Stage 1 patients contrasts with established literature, which typically reports 5-year survival rates of 70%–90% for Stage I, particularly following surgical resection[32]. This discrepancy may be related to factors such as late referral or tumor-specific molecular markers[31]. Consistent with previous studies[33,34], the advanced stages (Stage IV) demonstrated the poorest survival, with no patients surviving beyond two years in this study.

The Kaplan-Meier survival curve for inpatients (**Figure 3**) showed that the longest survival (48 months) was achieved by the combination of Chemotherapy and Radiotherapy (Intervention 4), despite a low survival rate (18%). The shortest duration of survival was observed in patients receiving radiotherapy alone (Intervention 2), despite an initial 100% survival rate. For outpatients (**Figure 4**), the triple-modality therapy (Chemotherapy, Radiotherapy, and Surgery - Intervention 7) resulted in the most extended survival (52 months), with a survival rate of 17%. Chemotherapy alone (Intervention 1) yielded the highest survival rate (50%).

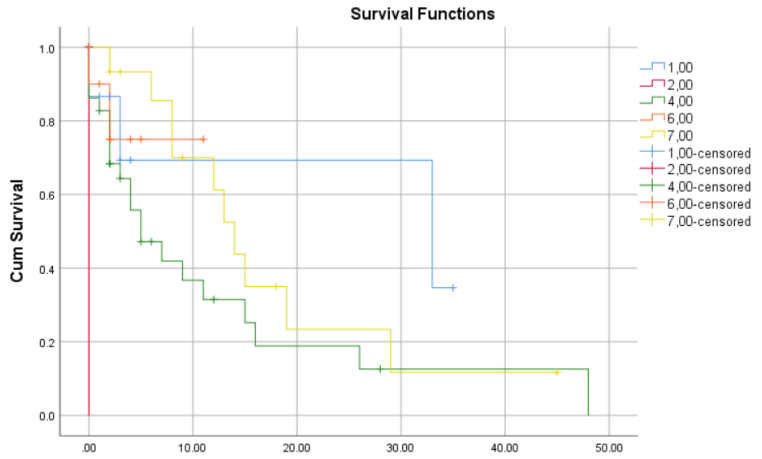

Figure 3. Kaplan-Meier survival curve: association between treatment interventions and survival in lung cancer inpatients and outpatients.

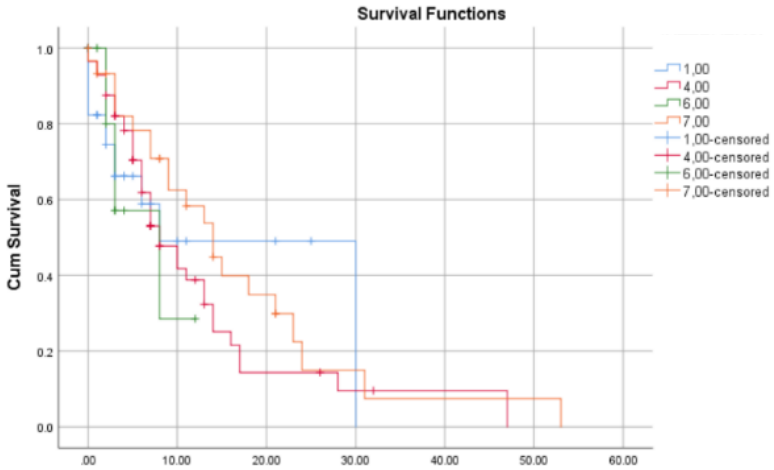

Figure 4. Kaplan-Meier survival curve: association between treatment intervention and survival in lung cancer outpatients.

The Log-rank test (**Table VII**) demonstrated a statistically significant difference in survival among inpatients based on the intervention received (p = 0.002), but no significant difference was found among outpatients (p = 0.442). The interventions administered (surgery, radiotherapy, and chemotherapy) are in line with the National Guidelines for Medical Services for Lung Cancer Management, where treatment choice is strongly influenced by disease stage, patient performance status, and comorbidities[35]. The finding that Chemotherapy and Radiotherapy (Intervention 4) and the triple-modality therapy (Intervention 7) were associated with the most extended survival aligns with the complexity of treating advanced disease, as these combinations are typically indicated for Stage IIIA and complex Stage IV cases[36]. The significant difference in survival among inpatients based on intervention confirms that the treatment modality is a critical factor in this patient group, often comprising those with more severe disease. Modern standards of care, such as Concurrent Chemoradiotherapy (CCRT) followed by immunotherapy (durvalumab) for Stage III NSCLC, represent the current optimal approach[37]. However, as CCRT is highly toxic, effective supportive care, including nutritional support, management of acute toxicities (e.g., esophagitis, dysphagia), and mitigation of fatigue, is crucial for managing severe adverse effects and improving patient tolerance and outcomes[38].

Table VII. Log-rank test: association between treatment intervention and survival in lung cancer inpatients and outpatients.

Category	Chi-Square	df	Sig.
Log-rank (Mantel-Cox)			
Inpatient	17.239	4	0.002
Outpatient	2.692	4	0.442

CONCLUSION

The analysis of one-year survival rates in patients with lung cancer reveals a complex, multifaceted relationship encompassing survival metrics, treatment modalities, and associated costs. Critically, a higher one-year survival rate was not uniformly correlated with a longer overall survival duration; for instance, patients diagnosed at Stage I demonstrated extended long-term survival despite presenting with comparatively modest one-year survival rates. Interventions that integrate chemotherapy, radiotherapy, and surgery have proven to be the most effective strategy for significantly prolonging patient life, even when their short-term (one-year) survival rates remain modest. Furthermore, treatment costs exhibited substantial variability driven by both cancer stage and the care setting. Specifically, inpatient care was found to be the most expensive modality for Stage II patients, while surgical interventions primarily escalated overall outpatient costs. These comprehensive findings underscore the necessity of moving beyond singular metrics, such as the one-year survival rate, to adopt a nuanced understanding of survival duration and cost-effectiveness when formulating and evaluating optimal treatment strategies for lung cancer.

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AUTHORS' CONTRIBUTION

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Writing - review & editing: Fitriana Yuliastuti, Nurfina Dian Kartikawati, Roshan Kumar Mahato

DATA AVAILABILITY

None.

CONFLICT OF INTEREST

The authors declared no conflict of interest related to this research.

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