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ORIGINAL

Examining the Impact of Age on Chemotherapy Effectiveness among Lung Cancer Patients

Análisis del impacto de la edad en la eficacia de la quimioterapia entre pacientes con cáncer de pulmón

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ABSTRACT

Introduction: lung cancer remains a prevalent type of cancer that affects many people and causes their death. Variations in chemotherapy effectiveness among different age groups of lung cancer patients can influence treatment outcomes, necessitating an investigation into age-specific responses to chemotherapy. The research aims to examine the impact of age on chemotherapy effectiveness among lung cancer (LC) patients, focusing on overall survival time, response rate, and comorbidity scores across different age categories.
Method: a total of 300 lung cancer patients undergoing chemotherapy were surveyed. Patients were divided into three age groups: ≤ 50 years, 50–69 years, and ≥ 70 years. Data analysis was performed using SPSS 25, employing descriptive statistics, regression analysis, correlation analysis, and ANOVA to evaluate factors affecting chemotherapy outcomes.
Results: descriptive statistics revealed the highest average survival time of 36 months with a response rate of 90 %. Regression analysis identified an intercept of 62,00, with negative coefficients associated with increasing age and advanced disease stage. Correlation analysis showed a positive correlation of 0,45 between response rate and survival time. ANOVA indicated an average response rate of 67,8 % among patients aged below 50, suggesting a potential benefit in tailored treatment strategies for younger patients.
Conclusions: these results support the treatment of patients with lung cancer, according to their age in an attempt to improve the outcomes of chemotherapy sessions. The research highlights a need for further research into age-related factors that influence treatment outcomes, emphasizing personalized approaches for improved patient care.

Keywords: Lung Cancer Patients; Chemotherapy; Age; Descriptive Statistics.

RESUMEN

Introducción: el cáncer de pulmón sigue siendo un tipo de cáncer muy frecuente que afecta a muchas personas y causa su muerte. Las variaciones en la eficacia de la quimioterapia entre los diferentes grupos de edad de los pacientes con cáncer de pulmón pueden influir en los resultados del tratamiento, lo que hace necesario investigar las respuestas específicas de cada edad a la quimioterapia. El objetivo de la investigación es examinar

el impacto de la edad en la eficacia de la quimioterapia entre los pacientes con cáncer de pulmón (CP),centrándose en el tiempo de supervivencia global, la tasa de respuesta y las puntuaciones de comorbilidad en diferentes categorías de edad.
Método: se encuestó a un total de 300 pacientes con cáncer de pulmón sometidos a quimioterapia. Los pacientes se dividieron en tres grupos de edad: ≤ 50 años, 50-69 años y ≥ 70 años. El análisis de los datos se realizó con SPSS 25, empleando estadísticas descriptivas, análisis de regresión, análisis de correlación y ANOVA para evaluar los factores que afectan a los resultados de la quimioterapia.
Resultados: las estadísticas descriptivas revelaron que el tiempo medio de supervivencia más alto fue de 36 meses, con una tasa de respuesta del 90 %. El análisis de regresión identificó una intersección de 62,00, con coeficientes negativos asociados al aumento de la edad y al estadio avanzado de la enfermedad. El análisis de correlación mostró una correlación positiva de 0,45 entre la tasa de respuesta y el tiempo de supervivencia. El ANOVA indicó una tasa de respuesta media del 67,8 % entre los pacientes menores de 50 años, lo que sugiere un posible beneficio de las estrategias de tratamiento personalizadas para los pacientes más jóvenes.
Conclusiones: estos resultados respaldan el tratamiento de los pacientes con cáncer de pulmón en función de su edad, con el fin de mejorar los resultados de las sesiones de quimioterapia. La investigación destaca la necesidad de seguir investigando los factores relacionados con la edad que influyen en los resultados del tratamiento, haciendo hincapié en los enfoques personalizados para mejorar la atención al paciente.

Palabras clave: Pacientes con Cáncer de Pulmón; Quimioterapia; Edad; Estadísticas Descriptivas.

INTRODUCTION

Chemotherapy is one of the most effective means to treat the affected patients in their late stages.[1] Chemotherapy, is not quite effective for most patients, and age plays a significant role in the results achieved. As the number of people with lung cancer worldwide continues on increasing, age's impact on chemotherapy effectiveness has also received more attention, which is an emerging focus for oncology services.[2] The patients' age is another factor that influences the effectiveness of chemotherapy because it causes changes in the organs' function, the metabolism of the chemicals in the body, and the presence of other diseases.[3] It is observed that standard chemotherapy regimens cause higher toxicity in older adults compared to younger adults, resulting in potential adverse effects, such as fatigue, neutropenia, and organ damage. Such outcomes cannot impair the capacity for treating tolerance but can also cause treatment interruptions or dose decreases, which in turn impact the general efficacy of the therapy.[4]

In contrast, young patients who have more physiological reserves as compared to older patients are less likely to be affected severely by the toxic effects of chemotherapy. It is also possible that younger patients survive in part due to having fewer concomitant illnesses that would prevent the use of more intensive therapeutic interventions.[5] These general trends should not mislead that the genetic template of the tumor, the biological aspects of the tumor or the responder, or age do not influence chemotherapy response. Thus, the issue of whether older age reduces the chances of benefiting from chemotherapy is still not well answered. Certain investigations suggest that when elderly clients are properly selected and supervised, their survival probabilities are not significantly different from those of younger individuals who also develop cancer.[6] Recent innovations in geriatric assessments, pertinently, the emergence of chemo-sensitive diseases, have enabled the expansion of chemotherapeutic applications to aged populations with far-off reduced toxicities. It is easier to anticipate how age affects chemotherapy outcomes and, ensure that older or young people get the best results when chemotherapy is used in the management of LC.[7] The research examines the impact of age on chemotherapy effectiveness among lung cancer patients.

Section 2 provides a list of literature reviews. In section 3, the method is explained. Section 4 includes the findings and the conclusion is provided in section 5.

Literature review

After carefully evaluating and comparing the prediction performance of the several models provided.[8] Finding LC individuals having metastatic bone cancer who had a significant chance of death, guiding risk counseling, and supporting clinical treatment decision-making were all possible with the model, which can be a useful risk prediction tool. For individuals in the high-risk group, less invasive surgeries like cementoplasty, the greatest supportive care, or radiotherapy were the better choices.

The prior trials provided evidence that adjuvant chemotherapy had positive effects in patients with non-small-cell lung cancer (NSCLC) was presented in [9]; there was an opportunity for improvement in terms of long-term survival. Postsurgical Deoxyribonucleic Acid from circulating tumors (ctDNA) identification of reputable NSCLC with adjuvant chemotherapy might be able to identify patients with a higher chance of recurrence and

provide individualized treatment.

There was limited information available regarding how chemotherapy dose intensity affects survival in individuals with NSCLC. A retrospective analysis of the relationship among chemotherapy intensities and mortality in developed NSCLC, relative dose intensity (RDI), or dose delays/reduction was conducted.[10]

The estimations of lung cancer incidence, death, and survival trends by subtype based on population data were demonstrated.[11] The SEER program (surveillance, epidemiological science and ending results), which consistently records and categorizes the most newly confirmed cancer patients within the registry catchment areas, provided exceptional cancer-registry data from which these estimates were produced. Furthermore, these studies were expected to contain sufficient numbers of older, sicker patients with lower incomes, and findings were more applicable compared to those from particular centers.

The factors that influence how individuals with advanced NSCLC respond to immune-checkpoint inhibition. In particular, the correlation with the response of several simple pre-treatment blood indicators that were accessible through regular testing was examined.[12] After employing traditional statistical methods, it created a machine-learning model for individual predictions.

For individuals having early stage (node-negative) NSCLC, the investigation [13] determined no correlation between tumor size and enhanced adjuvant treatment efficacy. Tumor size and high-risk clinic pathologic characteristics should be taken into consideration at the same time when assessing patients with early stages NSCLC for adjuvant treatment.

The rate of NSCLC was reduced in the research [14] including subgroups by age and gender. Through enhanced screening during the previous years, the rate of stage I NSCLC on diagnosis had probably increased. A higher overall frequency of NSCLC and a higher survival rate than previously reported, which could be related to earlier NSCLC finding and the development of better treatments.

The multicenter, large-scale examined in [15], which included a greater number of patients. Recurrence-free survival (RFS) and overall survival (OS) were extended by adjuvant treatment for stage non-small cell lung cancer (NSCLC) with risk factors. When visceral lung involvement or vascular intrusion was presented, adjuvant chemotherapy might be given special consideration among the other high-risk characteristics.

METHOD

Data gathering from lung cancer patients using surveys is the first step in the technique. Age, overall survival time, response rate, and comorbidities score were among the elements assessed. Using SPSS software, the analysis employed regressions, correlation, ANOVA, and descriptive statistics.

Data collection

Table 1. Demographic data

Demographic Variable		Category
Age Group	Under 50	80
	50-69	120
	70 and Older	100
Gender	Male	150
	Female	150
Cancer Stage at Diagnosis	Stage I	60
	Stage II	90
	Stage III	90
Invasion depth (mm)	Stage IV	60
Comorbidities	None	120
	1 Comorbidity	90
Lymph Node Status	2+ Comorbidities	90
Treatment Regimen	Platinum-based	150
Tumor grade	Non-platinum-based	150
Performance Status (ECOG)	0 (Fully active)	90
	1 (Restricted in physically)	150
Treatment type	2 (Ambulatory)	60
Chemotherapy Response	Complete Response	70
	Partial Response	120

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Surveys with 300 lung cancer patients who are undergoing chemotherapy were gathered. The survey includes questions about their quality of life, treatment side effects, emotional well-being, and adherence to the prescribed chemotherapy regimen. Responses are collected using a structured questionnaire, ensuring both closed-ended and open-ended questions to capture detailed patient experiences. The data was categorized into three age groups: 50 years or younger (N=100), between the ages of 50 and 69 years (N=100), and 70 years and above (N=100). Figure 1 and table 1 provide a summary of the demographic data where the gender, race/ethnicity, cancer staging, and comorbidities were outlined in the research sample.

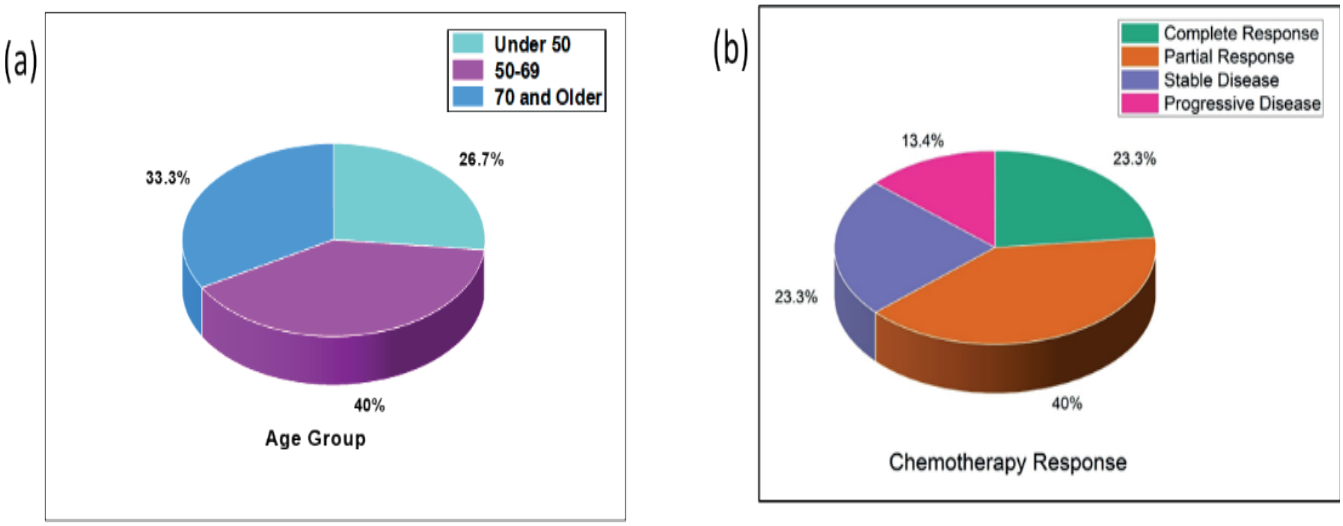

Figure 1. Demographic data

Statistical analysis

In the statistical assessment, several analytical methods were utilized. Descriptive analysis is a method of presenting data in terms of the median, mode, mean, range, variation, and frequency distribution to describe the kind of data that is being analyzed. Regression analysis is the technique that helps the individual to understand relationships between variables as well as to make predictive assumptions concerning certain patterns and tendencies within a set of data. The direction and level of the relationship between the variables are determined using correlation analysis. ANOVA compares the means of the groups and is an evaluation of variance. It tests for inequality, assuming normality and equal variances.

RESULTS

The effects of age on the response of LC patients to chemotherapy were evaluated using descriptive statistics, regression analysis, correlation analysis, and ANOVA, which are the components mentioned in this section.

Descriptive Statistical

Descriptive statistics have provided practical findings on the influences of age on the efficacy of chemotherapy in lung cancer cases. The age distribution shows that it is a representative research with significant subgroups of young patients under 50, middle-aged patients between the ages of 50 and 70, and elderly patients over 70 years. Some previous findings indicate better outcomes of the treatment in young patients compared to older patients, who can likely to develop side effects and seem to have a low level of response to the treatment. Response variations point to varied treatment results in line with age differences. These findings underscore the importance of tailoring treatment protocol to age, though limitations, like sample size and confounding factors must be acknowledged for accurate clinical implications, as shown in figure 2 and table 2.

The table defines the main features of patients who are concerned with further analysis to determine how effective chemotherapy is in treating lung cancer and whether age is a significant factor. The average age in the sample, which is 65,4 years with age ranges from 40 to 89, making it possible to do a comparison from middle age to the elderly population. The analyzed data show that patients survive 18,2 months on average after the treatment in question, though responses differ greatly (mean 55,3 %, ranging between 20 and 90 %). Other characteristics include: comorbidities score, mean 15,8, which means there are significant health issues that could impact outcomes. Based on these descriptive statistics, the analysis offers a starting point to investigate whether this patient population (older patients) obtains different survival and response rates than younger patients regarding chemotherapy response and the presence of comorbidities.

Table 2. Result of Descriptive statistical

Variable	Mean	Median	SD	Min	Max
Age (Years)	65,4	66	10,5	40	89
Overall Survival Time (Months)	18,2	16	5,2	6	36
Response Rate (%)	55,3	50	15,0	20	90
Comorbidity Score	15,8	15	5,2	5	30

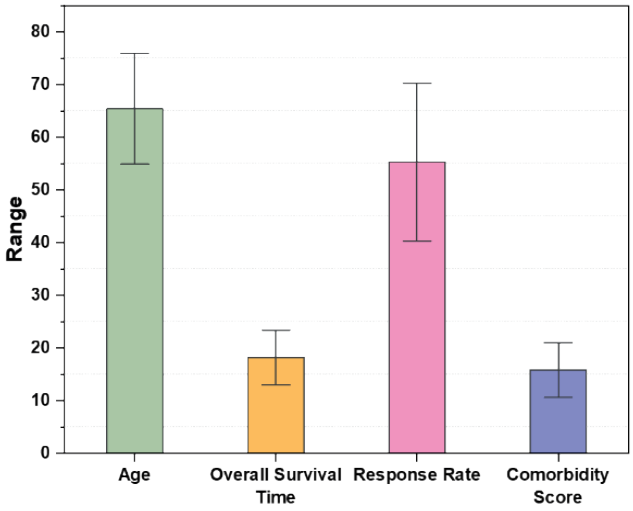

Figure 2. Descriptive Statistical Result

Regression Analysis

An analytical tool that can be used in the procedure is regression analysis for finding the relationship between a variable, specifically ages and chemotherapy effectiveness in lung cancer patients. Simple regression is one of the methods that can be applied, as long as the information gathered includes the ages of the patients and the results of their therapies. These are evaluations of the significance of the coefficient of age and testing of confidence intervals. A positive coefficient means that the effectiveness of chemotherapy improves with age, while a negative coefficient indicates poor chemotherapy effectiveness with rising age. The p value ($p<0,001$) is significant and t-value shows the importance of predicting variables in regression. Checking regression assumptions is a very important step for valid results that can help in guiding further treatment regimens for patients diagnosed with lung cancer. Table 3 presents the result of the regression analysis.

Table 3. Result of Regression Analysis

Variable	Coefficient (β)	Standard Error	t-value	p-value
Intercept	62,00	2,54	24,4	< 0,001
Age (Years)	-0,55	0,15	-3,67	< 0,001
Stage (1,2,3)	-2,10	0,45	-4,67	< 0,001
Comorbidity Score	-1,20	0,30	-4,00	< 0,001

The regression analysis does show the existence of various associations between age, the stage of the disease, and the comorbidities score and dependent health result. A value of 62,00 obtained from the intercept represents the initial measurement. The existence of a significant negative trend of -0,55 ($p<0,001$) of the outcomes for every year of age increase and a negative impact of -2,10 ($p<0,001$) for every higher disease stage were recorded. Also, the outcome reduces by -1,20 units with each incremental increase in the comorbidities score. Thus, these results indicate that the older population with more progressive stages of the disease and higher comorbidities has worse health outcomes and an important focus on healthcare services should be assigned to them.

Correlation Analysis

The correlation analysis explores the relationship between age and chemotherapy effectiveness among lung cancer patients, focusing on indicators, such as tumor response rates, progression-free survival (PFS), and

overall survival (OS). If statistically significant (p < 0,005), a higher coefficient in variables 'r' close to '+/- 1' denotes a strong positive or negative relationship, respectively. The findings can reveal a negative association between age and chemotherapy response, suggesting that older patients experience poorer outcomes. This indicates that age impacts treatment effectiveness, emphasizing the need for tailored strategies to improve chemotherapy outcomes for older lung cancer patients. Table 4 presents the correlation analysis result.

Table 4. Result of Correlation Analysis

Variable	Correlation Coefficient (r)	t-value	p-value
Age (Years) & Overall Survival Time (Months)	-0,30	-4,83	< 0,001
Age (Years) & Response Rate (%)	-0,25	-2,00	< 0,045
Age (Years) & Comorbidity Score	0,15	1,17	0,243
Overall Survival Time (Months) & Response Rate (%)	0,45	5,51	< 0,000
Overall Survival Time (Months) & Comorbidity Score	-0,10	-1,32	0,180
Response Rate (%) & Comorbidity Score	-0,05	-0,56	0,580

The correlation analysis shows there are significant associations between age, OS time, and response rate. As for other clinical factors, it found that older patients had less overall survival and lower response to treatment, which are negatively correlated with age at a moderate level (r= -0,30 for overall survival and r= -0,25 for response to treatment). But survival time and response rate have a weak to moderate positive correlation; in fact, the coefficient is r = 0,45, which shows that patients who live longer are more responsive to treatment. The comorbidities score has a small or insignificant correlation to age, response rate, and overall survival. The relationship between the comorbidities score and the different factors needs to be studied further to determine the utility in clinical practice.

ANOVA

The means of three or more independent groups are compared statistically using an ANOVA to identify whether any variations are statistically significant. Determining whether variation among groups is greater than that within groups is a crucial first step. When performing an ANOVA analysis for within-group variation rather than between-group variance (because of innovation), the F statistic (F), commonly known as the F ratio, is employed. Significant differences among the group means are indicated by a higher F value. When full potential outcomes are reached, the phrase P value is employed. The statistically significant changes that have been observed (p < 0,05) are most likely to a result of random variation, as shown in figure 3 and table 5 and table 6.

Table 5. a. Result of ANOVA

Age Group	Mean Response Rate (%)	Standard Deviation	Sample Size (n)
< 50 years	67,8	11,5	100
50-69 years	59,3	9,8	120
70 years and above	48,5	14,0	80

Table 6. ANOVA results of between and within groups

Variation	SS	df	MS	F-value	p-value
Between Groups	550,36	2	275,18	10,85	< 0,001
Within Groups	7600,64	297	25,59	-	-
Total	8150,00	299	-	-	-

In the given ANOVA table, the variable reveals the chemotherapy response rates among lung cancer patients based on age. The analysis indicates that the mean response rate for patients under 50 years was 67,8 %, while for those aged between 50-69 years, it was 59,3 %, and for patients aged 70 years and above, it was 48,5 %, which is illustrated in the above figure. The between groups variation has the sum of squares 550,36 and the F = 10,85, whereas p 0,001, which points to the age classes' significant variations. The calculated sum of squares

in the Within Groups variation is 7600,64. From these observations, researchers can conclude that age is a significant factor in determining the effectiveness of chemotherapy as younger individual appears to benefit from the treatment. Potential future works can reveal more about the general differences between subgroups.

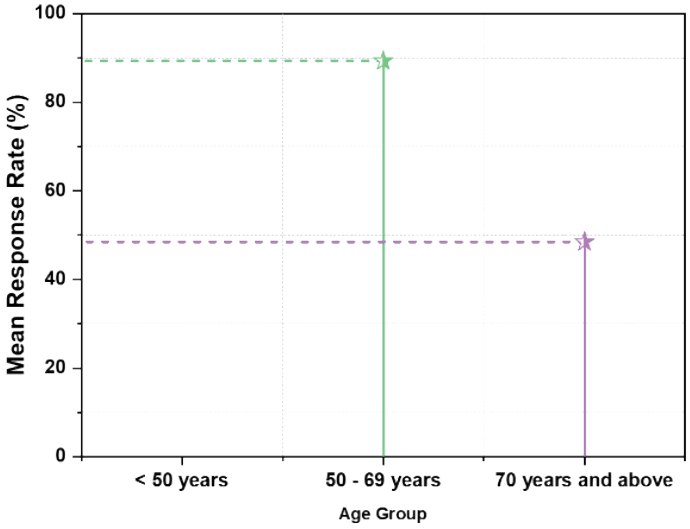

Figure 3. ANOVA Result

DISCUSSION

Consequently, patients diagnosed with cancer and who were undergoing anticancer therapy were reported to have a poor quality of life (QoL0).[16] It was also evident that anticancer treatment resulted in a greater reduction in functional well-being than emotional well-being among patients. The findings showed that the patient's educational status and employment status affected the patients' QoL. In individuals with advanced NSCLC, investigation [17] provided one of the biggest and strongest evaluations to date, comparing the results of 1L I-O with chemotherapy vs. I-O immunotherapy. Survival projections were generally lower than those from critical research, even after excluding patients who were not eligible for participating in medical tests. These findings imply that 1L regimens based on a single I-O drug in individuals with progressive NSCLC, as well as the identification of patient subgroups not benefiting from current I-O regimens, can indeed enhance real-world survival outcomes. Overall survival (OS) and progression-free survival (PFS) were consolidated in research [18] for patients with unrespectable LC (LC-NSCLC). It was crucial to investigate the efficacy and adverse effects of the treatment in real-world clinical settings since individuals having unrespectable LA-NSCLC were variable in terms of their tumor loads and clinical characteristics. The complete OS assessment was presented [19] for the wild type (WT) groups with high- or intermediate PD-L1 expression from IMpower110. In the group with high PD-L1 expression, the OS advantage with atezolizumab exceeded the requirement in relevance at the stage of interim OS analysis, which was regarded as the main analysis for that group. The addition of sugemalimab to platinum-based chemotherapy irrespective of NSCLC pathologies or PD-L1 expression was proved as discussed in [20] to be scientifically significant and clinically relevant in terms of improving progression-free survival compared with placebo plus chemotherapy.

CONCLUSIONS

Age has been revealed as an important factor that influences the response of lung cancer patients to chemotherapy. According to the findings, patients who are younger have higher responder percentages than those who are older, which promotes overall survival. In the statistical analysis, the research provided evidence on chemotherapy outcomes with lung cancer patients. Descriptive statistics indicate that the highest average survival time was 36 months with an apparent response rate of 90 %. The regression analysis showed that the intercept was 62,00, and the negative coefficients were found with the age and disease stage. The correlation analysis values of the response rates and survival time overall revealed that there was a positive correlation of 0,45. ANOVA revealed an average percentage response of 67,8 % among the patients below 50 years, suggesting that the treatment strategy should be formulated for such patients. These results indicate that modifications in treatment strategies according to the age of the patient can be crucial for improving chemotherapy outcomes in lung cancer patients, underlining the need for future investigations on age-related factors affecting the treatments of this disease. The current research had limitations, including the restricted sample size and the exclusively based data on chemotherapy, which can affect the possibility of generalizing the obtained results to other treatments for lung cancer. Further research should be carried out on more numerous and

heterogeneous patient groups and combine different treatment approaches, including immunotherapy, to enhance the understanding of the influence of age-related factors on lung cancer prognosis.

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CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

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