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# Cost of treating patients with smoking history in a specialized cancer hospital

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## ABSTRACT

**OBJECTIVE:** To describe the costs of treating lung, laryngeal and esophageal cancer among patients with histories of smoking.

**METHODS:** A longitudinal non-concurrent study on three cohorts with histories of smoking at a specialized hospital was carried out in the city of Rio de Janeiro, Southeastern Brazil, between 2000 and 2006. The sample was composed of 127 cases of lung cancer, 80 of laryngeal cancer and 35 of esophageal cancer. These cancers were selected through analyzing the frequencies and monetary values of the hospital admissions, weighted according to the fraction attributable to smoking among the population. Data were gathered from the medical files. Patients were classified according to their smoking profile, primary diagnosis, stage and comorbidities. The statistical analysis included the log-normal distribution to adjust for cost values and the Spearman correlation.

**RESULTS:** The patients were heavy smokers and were diagnosed at advanced stages. The burden from smoking was high, and 92%, 72% and 94% of lung, laryngeal and esophageal cancer patients, respectively, were diagnosed at advanced stages. The most frequent comorbidities were heart diseases and respiratory diseases. The mean costs of lung, laryngeal and esophageal cancers were R\$ 28,901, R\$ 37,529 and R\$ 33,164, respectively. The main cost drivers were radiotherapy and hospitalization. There was an association between advanced stage and lower cost for lung and esophageal cancer.

**CONCLUSIONS:** Since radiotherapy and hospitalization were the main total cost drivers, patients at more severe stages presented lower costs, probably because of the reduction in the number of therapeutic options.

**DESCRIPTORS:** Smoking. Neoplasms. Health Care Costs. Cohort Studies.

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## INTRODUCTION

Smoking is the most important preventable cause of morbidity and mortality around the world. It has been estimated that in 2015, tobacco will be responsible for 10% of deaths worldwide and it has been predicted that it will account for more than eight million deaths in 2030, of which 83% will occur in developing countries.<sup>11,15</sup> Recent data have indicated that the costs attributable to smoking are responsible for losses of 500 billion dollars per year, due to reduced productivity, illnesses and premature deaths.<sup>15</sup>

The epidemiological evidence available indicates a causal relationship between smoking and around 50 diseases, and prominent among these are

cardiovascular diseases, cancers and respiratory diseases.<sup>11,15,21</sup> Smoking is responsible for 29% in developed countries and 18% in developing countries.<sup>5</sup> Among the type of cancer with well-established associations with smoking, lung, laryngeal and esophageal cancers are prominent.<sup>15,21</sup>

In Brazil, out of these three tobacco-related types of cancer, lung and esophageal neoplasia are among the types with the highest incidence<sup>a</sup> and present significant lethality. Laryngeal cancer represents 2% of all cancers, which corresponds to around 9,000 cases per year.<sup>24</sup> The medical care for these three types of cancer is technology-intensive and requires a multi-disciplinary approach for diagnosis, treatment and rehabilitation. Within the scenario of finite resources in the healthcare sector, smoking generates an important opportunity cost for Brazilian public hospitals, in relation to the provision of oncological care resources such as consultations, hospital admissions, tests, high-complexity procedures and human resources that could be destined for treating other diseases.

The aim of the present study was to describe the cost of treating lung, laryngeal and esophageal cancers in patients with a smoking history.

## METHODS

This was a non-concurrent longitudinal study on three cohorts of patients with a smoking history who had been diagnosed with lung, laryngeal or esophageal cancer. These patients were treated at a specialized hospital in the municipality of Rio de Janeiro, Southeastern Brazil. The criteria for choosing this hospital unit were: 1) its regional importance for providing oncological care; and 2) its position within the structure of the National Cancer Institute (*Instituto Nacional do Câncer*, INCA), a body within the Ministry of Health that is responsible for developing and coordinating integrated actions for cancer prevention and control, and because it houses the structure and management of the National Tobacco Control Program.

The types of cancer were selected in accordance with associations with smoking that are well-established in the literature.<sup>3,5,15,21,24</sup> The database of the hospital information system of the Brazilian National Health System (*Sistema Único de Saúde*, SUS) was used obtain the frequencies and monetary values of hospitalizations due to these diseases in this hospital in 2003, in accordance with the three-digit categories of the International Classification of Diseases, tenth revision (ICD-10).

The results found were weighted according to the population-attributable fraction (PAF) relating to smoking, as presented in the World Cancer Report,<sup>17</sup>

which was based on data from the Cancer Prevention Study II (CPS II),<sup>21</sup> This study has been used to measure the burden and costs of smoking in several countries.<sup>13,14</sup> The main types of cancer relating to tobacco that were treated in this hospital were selected for cost analyses: i) non-small cell lung cancer (C34.0 to C34.9); ii) laryngeal cancer (C32.0 to C32.9); and iii) esophageal cancer (C15.0 to C15.9).

In order to select the comorbidities associated with smoking in the three cohorts, we took tobacco-related diseases with significant impact on morbidity and mortality (such as heart and respiratory diseases) to be proxies, in accordance with international estimates.<sup>15,21</sup> We also took into consideration the study conducted in Brazilian state capitals in 2003, which estimated that around 14% of the deaths that occurred among individuals aged 35 years or over (approximately 24,000 deaths) were attributable to tobacco.<sup>4</sup> The most representative diseases were heart diseases, lung cancer and chronic obstructive pulmonary disease.<sup>4</sup>

A pilot study conducted in the hospital showed that the most frequent comorbidities among the study population were hypertension and acute myocardial infarction, which were grouped as heart diseases; and asthma, chronic bronchitis and pulmonary emphysema, which were grouped as respiratory diseases. It was observed during the pilot study that a considerable number of diabetes cases were reported in the patients' files. For this reason, and because of the association between diabetes and smoking,<sup>7</sup> diabetes was also included as a comorbidity associated with the main diagnosis, and this was presented in the analysis as metabolic disease.

The clinical stages of each type of cancer were brought together into two groups because of the small number of cases in stages I and II. Thus, group 1 included stages I and II, and group 2 included stages III and IV. The criteria of the TNM malignant tumor classification of the Union for International Cancer Control, of 1998, were used.

Patients diagnosed in the hospital in 2000 who met the following criteria were included in the study: 1) individuals who declared that they were smokers or former smokers; 2) confirmation of cancer at the first diagnosis; 3) stage informed on the medical file during the diagnostic phase; and 4) medical care provided only at this hospital. To assess the patients' tobacco burden, the Brinkman index was used.<sup>2</sup> This is calculated as the product of the number of cigarettes smoked per day and the length of exposure in years, and it categorizes smokers as moderate (1 to 399) or heavy ( $\geq 400$ ).

Out of the total of 850 patients with the three types of cancer who were undergoing treatment in 2000, there

<sup>a</sup> Ministério da Saúde. Instituto Nacional do Câncer. Estimativa 2010: incidência de câncer no Brasil. Rio de Janeiro: INCA; 2009.

were 289 cases of lung cancer, 188 of laryngeal cancer and 70 of esophageal cancer that met the inclusion criteria for the sample. This population was divided into subpopulations according to clinical predictors (groupings of clinical stages and comorbidities), and systematic random sampling was applied. The final sample consisted of 242 patients, of whom 127 (53%) were lung cancer cases, 80 (33%) were laryngeal cancer cases and 35 (14%) were esophageal cancer cases. The patients with lung and laryngeal cancer were followed up retrospectively between 2000 and 2006 and the patients with esophageal cancer between 2000 and 2003. The diagnosis, treatment and follow-up were considered to be stages of the medical care.

Clinical information was gathered from the medical files and the hospital's managerial information systems, along with identification and quantification of supplies used. Two data gathering instruments were drawn up and applied by a trained professional: a clinical record form for obtaining data relating to exposure to tobacco, confirmation of the diagnosis, and the stage and presence of comorbidities; and a record spreadsheet relating to supply data, in order to calculate the costs.

The descriptive cost estimate followed the cost-per-patient method,<sup>12</sup> starting from following up the path taken through different clinics, based on INCA's absorption cost system (cost center) for 2002. The current values of 2002 were adjusted for the general inflation that occurred between 2002 and 2006, using the Brazilian Consumer Price Index, with costs expressed in *reais* of 2006.

The total unit cost of each patient's treatment was calculated taking into consideration both outpatient and inpatient procedures. The timeframe related to the follow-up period for the three cohorts, which corresponded to six years for lung and laryngeal cancer and three years for esophageal cancer. The mean and median costs, standard deviation and total cost for the following care events were presented: consultations, tests, chemotherapy, radiotherapy and hospitalization. In the statistical analysis, the histograms of the cost distribution of the lung, laryngeal and esophageal cancer samples showed positive asymmetry. Log-normal adjustment of the distribution was performed. Spearman's correlation was used to analyze the relationship between the total unit cost and the stage. The data were analyzed using the R 2.11.1 and Stata 11 software.

The study project was approved by the research ethics committees of INCA (Protocol no. 75/05) on September 26, 2005, and the "Sergio Arouca" National School of Public Health (Report no. 31/06) on April 5, 2006.

## RESULTS

The patients' mean age was 62 years (lung cancer), 61 years (laryngeal cancer) and 57 years (esophageal cancer). The majority of the patients died during the study follow-up period. According to the Brinkman index criteria, the population was classified as heavy smokers. Most of these patients were diagnosed in stages III and IV, with lung and esophageal cancer.

Most of the patients with esophageal cancer (20 cases) did not report any comorbidities associated with the main diagnosis. Some of the lung cancer patients (42 cases) and laryngeal cancer patients (33 cases) were also not diagnosed with these clinical conditions. In group 1, five cases with lung cancer, 11 with laryngeal cancer and one with esophageal cancer showed reports of the presence of comorbidities. For individuals in group 2 diagnosed with these conditions, respiratory and heart diseases predominated, while the patients with lung cancer (17 cases) and laryngeal cancer (8 cases) presented both conditions (Table 1).

The mean total cost per patient with lung cancer was R\$ 28,901 (SD 19,297) and the median was R\$ 26,029 for a period of six years. The treatment for 105 patients had a mean duration of one year, at a mean cost of R\$ 25,317 (SD 17,473) and median cost of R\$ 19,112. The mean total cost per patient with laryngeal cancer over six years was R\$ 37,529 (SD 31,538) and the median cost was R\$ 38,767. The mean treatment cost for 35 patients for a period of up to one year was R\$ 27,667 (SD 17,253) and the median cost was R\$ 30,576. The mean total cost for the sample of esophageal cancer patients was R\$ 33,164 (SD 24,468) and the median cost was R\$ 31,882 over a timeframe of three years. The cost values for 27 patients for a mean period of one year were, respectively, R\$ 28,722 (SD 22,835) and R\$ 30,369 (Table 2).

The log-normal adjusted distributions for the three cohorts made it possible to reduce the dispersion of the absolute values of the total unit treatment cost. The results from the correlation between the stage and the total unit cost of the treatment indicated that there was a moderate association between advanced stages and lower cost for the lung cancer samples (-0.48) and a weak association for the esophageal cancer samples (-0.22). The correlation for the patients with laryngeal cancer indicated that advanced stages were related to higher costs (0.07).

Radiotherapy and hospitalization were the main cost drivers and were responsible for 77%, 84% and 82% of the total cost of the lung, laryngeal and esophageal cancer samples, respectively (Table 3). All the patients underwent consultations and tests, and most of them underwent radiotherapy. Few of the patients with diagnoses of laryngeal or esophageal cancer

**Table 1.** Characteristics of patients with smoking history who were diagnosed with lung, laryngeal and esophageal cancer. Rio de Janeiro, Southeastern Brazil, 2000. (n = 242)

Characteristics	Cancer		
	Lung	Laryngeal	Esophageal
Number of cases	127	80	35
Mean age (years)	62	61	57
Smoking burden			
Mean daily cigarette consumption	26	29	25
Mean length of exposure (years)	40	40	38
Brinkman index	1.040	1.160	950
Result from care			
Clinical control	3	12	-
Death	120	57	32
No information <sup>a</sup>	4	11	3
Clinical stage			
Group 1			
Stage I	2	12	-
Stage II	8	10	2
Group 2			
Stage III	64	32	22
Stage IV	53	26	11
Comorbidities			
Group 1			
None	5	10	1
Respiratory disease	2	2	-
Heart disease	2	5	-
Metabolic disease	-	1	-
Metabolic + heart disease	1	1	1
Respiratory + heart disease	-	2	-
Group 2			
None	37	23	19
Heart disease	30	15	5
Respiratory disease	18	7	6
Metabolic disease	5	4	1
Metabolic + respiratory disease	1	1	-
Respiratory + heart disease	17	8	2
Metabolic + heart disease	8	1	-
Respiratory + metabolic + heart disease	1	-	-

<sup>a</sup>This refers to patients for whom it was not possible to identify all of their evolution at the hospital.

underwent chemotherapy, and such patients did not generate significant costs. Around 32% of the cases (41 patients) of lung cancer underwent chemotherapy, but the participation of this event was the smallest (3%) in the composition of the total cost.

## DISCUSSION

The medical care for the types of cancer analyzed in the present study changed over the course of the decade through incorporation or replacement of technologies within the healthcare sector. The pattern of oncological care went on changing dynamically through introductions of procedures, diagnostic equipment and medications that, along with other factors, contributed towards cost increases.

The population of patients with smoking history suggests that a significant disease burden existed, as expressed in the severity of the cases. The mean duration of the treatment of a significant proportion of the patients with lung cancer (105 cases), laryngeal cancer (35 cases) and esophageal cancer (27 cases) was one year.

Regarding the clinical stage, 94% of the patients with esophageal cancer, 92% with lung cancer and 72% with laryngeal cancer were diagnosed in group 2 (stages III and IV). Cersosimo<sup>3</sup> showed that 75% of lung tumors were classified in stages III and IV at the time of diagnosis, and that this type of cancer was among those with worse survival. The same was observed for laryngeal cancer, in which more than 60% of the cases were diagnosed in stages III and IV.<sup>1</sup> Esophageal cancer has an incidence/mortality ratio of close to one (0.89 for males and 0.96 for females). Late diagnosis is one of the factors responsible for this scenario, and thus, most patients are provided with palliative therapy.<sup>18</sup>

The presence of comorbidities is considered to be an important prognostic factor in cancer cases, as are the assessment and evolution of these conditions and their severity. Some authors have indicated that studies based on retrospective hospital-based cohorts have significant limitations with regard to correlating these smoking-related clinical conditions with certain outcomes, as concluded by Tho et al.<sup>19</sup> Even though the comorbidity frequency data from the present study did not allow any correlation between the presence of these conditions and greater use of healthcare resources, a considerable proportion of the patients presented comorbidities associated with the diagnosis of cancer, notably heart and lung diseases. Our findings corroborate those of Janssen-Heinjen et al,<sup>10</sup> who investigated the prevalence of comorbidities associated with lung cancer in the Netherlands, and those of Tomasich et al<sup>20</sup> regarding esophageal cancer in Brazil.

**Table 2.** Total cost and cost of first year of treatment among patients with lung, laryngeal and esophageal cancer. Rio de Janeiro, Southeastern Brazil, 2000 to 2006.

Cancer	n	Cost of treatment (R\$) <sup>a</sup>			Cost of the first year of treatment (R\$) <sup>b</sup>			
		Mean	Median	SD	n	Mean	Median	SD
Lung	127	28,901	26,029	19,297	105	25,317	19,112	17,473
Laryngeal	80	37,529	38,767	31,538	35	27,667	30,576	17,253
Esophageal	35	33,164	31,882	24,468	27	28,722	30,369	22,835

<sup>a</sup> The total cost corresponds to six years for lung and laryngeal cancer and three years for esophageal cancer.

<sup>b</sup> This refers to the group of patients whose treatment had a mean duration of one year.

**Table 3.** Numbers of patients and total cost per care event. Rio de Janeiro, Southeastern Brazil, 2000 to 2006.

Cancer	Radiotherapy	Hospitalization	Consultations	Tests	Chemotherapy
Lung					
n	111	104	127	127	41
Total cost (%)	R\$ 1,932,260 (53%)	R\$ 871,397 (24%)	R\$ 404,213 (11%)	R\$ 338,800 (9%)	R\$ 123,793 (3%)
Laryngeal					
n	59	71	80	80	3
Total cost (%)	R\$ 1,580,372 (53%)	R\$ 935,565 (31%)	R\$ 286,848 (10%)	R\$ 191,719 (6%)	R\$ 7,812 <sup>a</sup>
Esophageal					
n	30	33	35	35	2
Total cost (%)	R\$ 695,781 (60%)	R\$ 258,883 (22%)	R\$ 94,969 (9%)	R\$ 105,722 (9%)	R\$ 5,380 <sup>a</sup>

<sup>a</sup> There was no significant use of chemotherapy procedures.

Other limitations of the present study need to be pointed out. There were losses of information regarding resource use, since the data were gathered mainly from the medical files, even though the hospital's managerial systems were accessed in an attempt to minimize such losses. The possibility of memory bias among the patients regarding information provided on cigarette consumption and length of exposure needs to be considered. Such bias may have influenced the smoking burden results shown through the Brinkman index. However, the length of exposure and quantities of cigarettes consumed were very similar between the three types of cancer, which suggests that there was no significant interference in the results.

It is recognized that there are limitations to using an international PAF as a weighting method, since the relative risks should be estimated for each population, with incorporation of the specific biological, cultural and economic characteristics. The limitations to international PAFs related to using relative risks obtained from CPS II. The sample for this study was not representative of the population, since it included greater numbers of individuals who were married, had white skin color and had higher education and income levels. Moreover, the estimates were only adjusted for age, and important confounding variables such as alcohol use, hypertension and diabetes mellitus were not taken into consideration. However, because of the absence of Brazilian relative risk data that would allow calculation

of a national PAF, the available estimates were applied to this study.

In our analysis, it was observed that the cost was lower when associated with the more advanced stages among the populations with lung and esophageal cancer. These results may have been related to the fact that more than 90% of the patients with lung and esophageal cancer were diagnosed at advanced stages, which reduces the therapeutic options, as well as the survival. Our finding of an association between laryngeal cancer cases at advanced stages and higher costs agrees with those of Arnold et al,<sup>1</sup> who found that the mean cost of two years of treatment increased according to the stage.

Even though smoking was responsible for a burden of morbidity and mortality that was measurable through the use of health service resources, we cannot affirm that the hospital cost of the lung, laryngeal and esophageal cancers observed in the present study was attributable to smoking. For this, it would be necessary to conduct population-based cohort studies, in order to quantify the additional use of healthcare resources by patients who were smokers, in comparison with nonsmokers. Such an analysis was carried out in Japan, in which the cost of medical care for men who were smokers was 11% greater than the estimate for patients who said that they had never been smokers. The difference was attributed mainly to the use of hospital resources, for which the monthly cost was 33% greater among the population of smokers.<sup>9</sup>



Studies have estimated the hospital cost of lung, laryngeal and esophageal cancer in developed countries like the Netherlands, Switzerland, Canada, United States and United Kingdom.<sup>1,6,8,16,22,23</sup> Direct comparison between the results from the present study and these surveys is possible, although limitations relating to the heterogeneity of the methods used and the specific features of hospital care in the different healthcare systems need to be taken into consideration. The amounts in euros and pounds in the European studies were transformed into dollars using the exchange rates of 2006.

Radiotherapy and hospitalization were the main components of the total cost of treating lung cancer. These results coincide with those of the retrospective cohort studies conducted in hospitals in Switzerland<sup>6</sup> and the United Kingdom,<sup>23</sup> in which these two care events were also the main drivers of the cost of treating non-small cell lung cancer. The mean cost of treating the 89 patients in the study carried out in Switzerland by Dedes et al<sup>6</sup> over a 2.5-year period was US\$ 25,286 (median = US\$ 19,099), while the result from 227 patients found by Wolstenholme & Whyne<sup>23</sup> in the United Kingdom over a four-year period was US\$ 12,070. In the United States, in a cohort from a group medicine company, the mean cost of patients with non-small cell lung cancer over a timeframe of up to 12 months was US\$ 40,485.<sup>8</sup>

In relation to laryngeal cancer, radiotherapy and hospitalization were the main cost drivers in our hospital. The analysis by Van Agthoven et al<sup>22</sup> in the Netherlands also identified that hospitalization was an important cost driver, and treatment for patients with primary tumors

reached a mean of US\$ 28,769 in a cohort of patients followed up for two years.

The results found in the present study for care provided for patients with esophageal cancer showed the same behavior as seen for lung and laryngeal cancers, in relation to radiotherapy and hospitalization. An American study that investigated the healthcare usage profile of 29 patients with esophageal adenocarcinoma between 1992 and 1997, also found that radiotherapy was one of the main cost items. The care provided for this population had a mean cost of US\$ 48,127, but with around a tenfold range between the minimum and maximum amounts (US\$ 13,454 and US\$ 139,721).<sup>16</sup>

In conclusion, this study presented descriptive data on healthcare resource consumption among patients with high smoking burden, although we cannot affirm that the cost of smoking-related cancers was attributable to smoking. The smoking epidemic is expressed especially in healthcare services, including hospitals. It would be worthwhile undertaking further investigations that might identify the real economic magnitude of the diseases associated with tobacco, in order to furnish backing for administrators in introducing and strengthening actions and strategies for controlling smoking.

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