Spending Estimates for Gastric Cancer in Central Brazil

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Stomach cancer is the second leading cause of death by cancer worldwide and is even more pronounced in South America. In Brazil, it is estimated that an increase in the number of cases due to this cancer occurred in the biennium 2018-2019. In this study, we investigated the expenditures of the State Health Department of Goiás on hospitalizations and treatment of gastric cancer for the Unified Health System (SUS) from 2008-2016. This is a cross-sectional, descriptive, and analytical study based on secondary data from the Unified Health System computing department (DATASUS) and the System of Management of the Table of Procedures, Medications, Orthosis, Prosthesis, and Special Materials of SUS through CONECTA-SUS related to International Classification of Diseases-10/C16 (ICD-10/C16) procedures for gastric neoplasms. A total of I$ 5,697,958.20 was spent on gastric tumor in the last nine years in Goiás, I$ 4,492,916.67 (0.3%) on hospitalizations, and I$ 1,997,120.91 on treatment. This study presents a current and relevant estimate of the costs of gastric cancer patients in Goiás. Moreover, we provide information on the extent of the cancer issue to public health. Our analysis offers components for service management and studies that reduce resource allocation in more rational ways.

Keywords: Gastric neoplasms. Treatment. Spending. Cost. Cost analysis.

INTRODUCTION

According to the Pan American Health Organization (2018), cancer is considered the second leading cause of death in the world. The number of deaths between January and September of 2018 reached 9.6 million, with more than 60% of the deaths occurring in Africa, Asia, and Central and South America. This death rate indicates that, worldwide, every six deaths are related to cancer, and approximately 70% of deaths occur in low- and middle-income countries.

Stomach cancer is the sixth most common type of cancer worldwide, with 1.03 million cases. Moreover, stomach cancer is the third most deadly neoplasia, with 783.000 deaths per year. Stomach neoplasms belong to the C16 group of the international classification of diseases and problems related to health (WHO, 2014a; WHO, 2014b). The most common histopathological type of gastric cancer is adenocarcinoma, which corresponds to more than 90% of gastric cancer cases (WHO, 2014a; PAHO, 2018; INCA, 2015).

There are two stomach adenocarcinoma subgroups: the Lauren diffuse and the intestinal type. Lauren's syndrome presents as an infiltrative pattern with a submucosal extension and early metastasis, affects more

young women of the blood type A, and is associated with a worse prognosis. The intestinal form presents as a more differentiated tumor, affects more men, especially the elderly, and evolves mainly from pre-malignant lesions (INCA, 2015).

In Brazil, there were an estimated 13,540 new cases of stomach cancer in men and 7,750 in women for the biennium 2018-2019, making stomach cancer the fourth most common type of cancer in men and the sixth in women. These values correspond to an estimated risk of 13,11 new cases per 100,000 men and 7,32 per 100,000 women. In the central-western region of the country, stomach cancer is the fourth most frequent type of cancer in men and the fifth in women (INCA, 2017).

The etiology of gastric cancer is not fully elucidated, but there is a strong correlation between the increased risk of onset and development of the disease. The known risk factors include infection with *Helicobacter pylori* (*H. pylori*); advanced age; male sex; eating habits, such as low fruit and vegetable intake; high salt intake from smoked or preserved foods; exposure to drugs, such as smoking; preexisting gastric conditions; and family history (Brasil, 2017; INCA, 2015; WHO, 2014a; Karimi *et al.*, 2014; WHO, 2014c).

Bacterium infection was classified as a type I carcinogen by the International Agency for Research on Cancer (IARC) due to *H. pylori's* association with gastric cancer. Exposure to the pathogen contributes not only to the development of adenocarcinoma but also to the worsening of the neoplasia. For this reason, eradication of *H. pylori* is a promising target for the reduction of adenocarcinoma, especially in countries with the highest rates of infection (WHO, 2014a; WHO, 2014c; Yamaoka, 2010; Zhang *et al.*, 2016).

Stomach cancer is diagnosed by upper digestive endoscopy and histopathological analysis. Tumor markers, such as carbohydrate antigen 72-4 (CA 72-4), carbohydrate antigen 19-9 (CA 19-9), and carcinoembryonic antigen (CEA) are useful to evaluate the patient's clinical conditions. After the histopathological and laboratory diagnosis, computed tomography of the abdomen and chest with contrast should be performed to define the staging and plan the treatment. The current therapeutic options are surgical curative intent, radiotherapy, and chemotherapy (Brasil, 2017; Chen *et al.*, 2017; Zhang *et al.*, 2016; Zilberstein *et al.*, 2013).

Data on the incidence, prevalence, and mortality are of fundamental importance to establish the burden generated by the disease and indicate the causal relationships and the priorities for controlling the disease. The global economic impact of cancer is significant and increasing, and, in 2010, the estimated total annual cost was I$1.16 trillion (WHO, 2014c). By conducting COI (cost of illness) studies, researchers are required to recognize, identify, list, measure, and value the costs that a disease generates (Drummond, *et al.*, 2005).

In this sense, it is necessary to calculate the financial resources spent by the Unified Health System (Sistema Único de Saúde – SUS) on the disease, since it is estimated that an increase in the number of cases will occur in the next years, and the diagnosis and treatment of these cases are of the high cost. This research aimed to estimate the expenditures of the State Health Department on health care for gastric neoplasms in the SUS of Goiás in the last ten years based on the transfer of the values described in the SUS table for each necessary procedure, as well as evaluate the number of deaths due to stomach cancer in Goiás.

MATERIAL AND METHODS

This study is an economical cost assessment of the gross disease costs, with a descriptive and analytical study of the expenses derived from gastric adenocarcinoma by the SUS in the State of Goiás, Brazil. The direct costs are derived from hospitalizations, chemotherapy, and surgeries, while the indirect costs refer to the loss of productivity, absenteeism, and deaths. In this research, we use the public system perspective to evaluate the direct costs of hospitalizations, advanced stage chemotherapy, and surgeries since the Unified Health System computing department (DATASUS) was designed to fulfill only an accounting role and does not assess indirect costs. The data were not updated for inflation because the DATASUS table that did not present monetary adjustment. Furthermore, we evaluated the number of deaths due to cancer in the state.

Summary cost measures were converted into international dollars (I$) in 2018 of the world bank (world bank, 2020), using purchasing power parity (PPP) to

facilitate the comparison of the results. This method is mitigated as foreign exchange interference from several countries when considering income distribution and purchasing power.

Identification of procedures related to gastric cancer was made through ICD-10 (WHO, 2014b) and the records in the System of Management of the Table of Procedures, Prosthesis, Medications, Orthosis, and Special Materials of SUS (SIGTAP), which was available in the Hospital Information System of SUS-SIH/DATASUS. The selected ICD-10 are described in Picture I.

Data collection occurred between September and October of 2018 in DATASUS, via Conecta SUS (Center for Strategic Information and Decisions in Health Zilda Arns Neumann) in the Department of Health of the State of Goiás (SES/GO). The data used were related to the cost of treatment, hospitalizations, and the number of deaths due to gastric neoplasms in the 246 municipalities in Goiás between 2008 and 2016.

According to Resolution number 510 of April 7, 2016, the Research Ethics Committee's approval was not necessary, since public domain databases were used without the subject's formal identification.

RESULTS

The analyses demonstrated that, in Goiás, there were 3,137,841 hospital admissions, of which 13,946 were due to various neoplasms, while 3.255 were related to gastric neoplasms (CID-10 C16). The total cost of hospital admissions due to gastric neoplasms (SIH/SUS) was I\$449,291,667, which corresponds to 0.3% of total hospitalization expenses related to other clinical conditions (Table I).

TABLE I - Data related to expenditures with general hospitalizations compared to expenses for hospitalization for gastric neoplasms in Goiás, from 2008 to 2016, according to the Hospital Information System of the Unified Health System (SUS)

Expenses with Hospitals in Goiás			Expenditure on Hospitalizations with the diagnosis of Malignant Neoplasms of Stomach CID-10 C16			Expenditures with diagnosis of malignant neoplasm of stomach in relation to expenditures with general hospitalization in Goiás
Year	Amount	Value	Amount		Value	%
			Women	Man		
2008	357.921	143,372,616.32	106	197	313,641.98	0.22
2009	361.816	139,226,834.94	153	192	373,503.08	0.27
2010	371.237	150,031,416.14	104	205	340,867.07	0.23
2011	352.880	160,786,722.34	134	228	478,463.41	0.30
2012	329.904	165,039,716.11	130	191	380,058.30	0.23
2013	349.089	185,100,169.93	155	343	686,284.08	0.37
2014	351.106	197,467,848.71	143	283	678,338.33	0.34
2015	350.792	206,157,874.21	125	224	629,432.08	0.30
2016	313.096	198,583,126.59	115	227	612,328.30	0.31
Total	3.137.841	1,367,599,741.17	1.165	2.090	4,492,916.67	
			3.255			

The expenditures for hospitalizations with stomach cancer increased by 80% (+I$306,225.78) in 2013, and because hospitalization value was stable since the subsequent years', the expenses declined. The decline in spending in 2014 was 1% (-I$7,945.74), followed by the years 2015 and 2016 with 7% (-I$48,906.24) and 2,7% (-I$17,103.78) declines, respectively. Even with slight declines, the growth of expenses was remarkable, as the amount spent in 2016 represents approximately double the amount spent in 2008 (Figure 1).

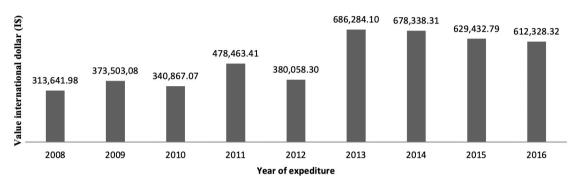## Stomach cancer hospitalizations

FIGURE 1 - Evolution of expenses for hospitalizations in the Unified Health System (SUS) related to stomach cancer in Goiás between 2008 and 2016.

The cost of surgical treatment for gastric neoplasms was I$1,079,538.64 in the last nine years. Of this amount, I$224,789.12 was spent on esophagogastrectomies and I$854,749.51 was spent on total gastrectomies. The highest expenditure occurred in 2009 for both surgical treatments and was I$58,869.07 for the former and I$185,051.07 for the latter surgical type, respectively. The cost of advanced chemotherapy between 2008 and 2016 was I$917,582.17, as shown in Table II.

TABLE II - Distribution of the costs related to surgical treatment and advanced chemotherapy of gastric neoplasms of the System of Management of the Procedures, Medications, Ortheses and Prosthesis Chart of the Unified Health System (SUS) between 2008 and 2016

| | Surgical treatment | | Chemotherapy of advanced stomach adenocarcinoma |
| | Esophagogastrectomy | Total Gastrectomy | |
Year	Value	Value	Value
2008	35,595.05	114,935.93	116,563.36
2009	58,869.08	185,051.07	111,632.92
2010	43,755.26	163,474.41	122,930.69
2011	31,409.21	173,933.58	85,725.00
2012	8,677.73	114,043.33	62,000.99
2013	20,750.71	20,912.81	95,910.14

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| | Surgical treatment | | Chemotherapy of advanced stomach adenocarcinoma |
| | Esophagogastrectomy | Total Gastrectomy | |
Year	Value	Value	Value
2014	7,613.73	36,937.91	140, 614.85
2015	3,785.13	24,914.52	98,802.97
2016	11,305.57	17,624.42	83,401.23
Total	221,761,50	851,828.01	917,582.17

When combining men and women, 53,285 individuals between the ages of 13 and 90 years died due to neoplasias in Goiás, 3,078 of which were due to stomach cancer. This number represents 5.7% of all deaths due to malignant neoplasms in the state (Table III).

By analyzing the evolution of deaths in a decade, we found a slight reduction in 2008 for both sexes. However, as of 2009, there was a considerable increase in deaths. We also observed that the number of deaths in men was higher, as shown in Table III.

TABLE III - The number of deaths in men and women over 13 years and under 90 years in Goiás due to gastric neoplasias according to ICD-10 C16 between 2007 and 2016

| Year | Number of deaths | | Total deaths per year |
	Man	Women	
2007	185	109	294
2008	164	102	266
2009	201	87	288
2010	196	98	294
2011	208	101	309
2012	193	94	287
2013	195	111	306
2014	212	123	335
2015	223	131	354
2016	215	130	345
Mean of deaths	199,2	108,6	307,8

DISCUSSION

The dissemination of health information, with free access in Brazil, was possible only in 1991 with the creation of DATASUS. Twenty-seven years after its inception, the interest in using the database has been increasing, mainly by the management of the health services (Brasil, 2009a; Brasil, 2009b).

The SIH/SUS is the only system of national scope. It was developed by the Authorizations of Hospital

Hospitalization (AIH) and was designed to pay for the hospitalizations of public and private hospitals associated with SUS. This system has the advantage of providing diagnostic, demographic, and geographical information for each hospital stay. When data are recorded correctly in the information system, they can be used for the epidemiological evaluation of health problems (Bittencourt, Camacho, Leal, 2006; Brasil, 2009b).

Since its development, the SIH/SUS has been the main instrument for the induction and evaluation of Brazilian public policies, mainly regarding the organization and financing of hospital care in the public health system. This system provides essential information for national expenditure (Bittencourt; Camacho; Leal, 2006).

This study evaluated the distribution of hospitalization expenses over nine years, including treatment expenses, and the number of deaths over ten years in the State of Goiás. We used only nine years of data related to hospitalization because there is no tabulation available in DATASUS for previous years. We found an increase in the spending standard as of 2009. The amount spent on hospitalizations for gastric neoplasms corresponded to 0.3% of the total expenditures, with hospital admissions in the SUS generated in Goiás. These data corroborate the estimate made by INCA (2017), in which a progressive increase in cancer is expected over the next few years. The considerable increase of cancer can be attributed to the lifestyle changes that accompany economic development, urbanization, and the aging population (American Cancer Society, 2015; Flannery *et al.*, 2018).

The I\$9,075,691.69 spent on hospital admissions and the total of I\$4,034,184.06 for surgical and medication procedures aimed at the treatment of advanced-stage cancer, I\$11,509,875.75 was spent on gastric neoplasms in the last nine years. This high demand for healthcare expenses for patients with neoplasia is justified not only by the epidemiological relevance of the disease but also by incorporating new technologies with increasing costs (Kust, 2015).

More importantly, the values described excluded the treatment expenses from the initial stage in pediatrics and indirect costs. Still, they show a high financial impact on the budget for treating pathologies related to ICD-10 C16. In addition to the indirect costs, which involve human losses caused deaths considered challenging to calculate, the financial cost is considerable and presents as a significant challenge. This cost difficulty is also present in countries like Brazil, which have access to a universal health system (Kust, 2015).

Cancer patient's care demands high expenditures not only for the epidemiological expression of the disease but also for incorporating new technologies with increasing costs. On the other hand, factors, such as delayed diagnosis, slow incorporation of new technologies in services, and the presence of areas lacking access to specialized services are reasons for the increase in the number of cases for advanced treatment (Featherstone, Whitham, 2010).

The incidence rate of gastric cancer in Brazil was 13.04 per 100,000 inhabitants in the biennium 2016-2017. In the biennium 2018-2019, it rose to 13.11, with the rate adjusted to 14.98. In the central-west region, the incidence rate per 100,000 inhabitants in 2016-2017 was 11.50, and in 2018-2019 it increased to 11.52. In Goiás, the gross rate is 10.5 per 100,000 inhabitants (INCA, 2015; INCA, 2017).

The leading cause related to the increased development of stomach cancer is *H. pylori* infection (Zhang *et al.*, 2016). The worldwide spread of the bacterium, the genetic polymorphism of the bacterial strain, the asymptomatic infection it triggers, the use of tobacco, old age, and the discovery at an advanced stage of stomach cancer also contribute to the increase in hospitalization expenses related to stomach cancer WHO, 2014a; Reis, Noronha, Wajnman, 2016; Zilbersteins *et al.*, 2013).

An increase in deaths due to stomach cancer in Goiás was observed between 2007 and 2016. There was a more dramatic increase in deaths from 2011 in both sexes. These data are in keeping with INCA's estimate (2017), but an even more considerable increase is expected for the 2018-2019 biennium. Despite a reduction in the incidence of gastric cancer since 1950, it still represents the third leading cause of cancer deaths in both males and females in the world (Giusti *et al.*, 2016).

The death rate in Goiás is approximately two times higher for males than for females. These data are similar to those in other regions of Brazil and in other countries

(El-Serag *et al.*, 2002; Giusti *et al.*, 2016). We could do further analysis to determine if deaths by human capital because of the loss of early death were observed, but that was not the objective of the study.

The possible causes associated with this disparity are the low demand for health services by men (Cavaleiro *et al.*, 2011) and the coexistence of other risk factors with unequal exposure, such as a greater use of tobacco and alcohol by men (El-Serag *et al.*, 2002; De Souza Giusti *et al.*, 2016; Reitsma *et al.*, 2017).

The world percentage of males who smoke rose from 16.3 to 19.7 per 100,000 inhabitants between 2007 and 2010. In women, the same percentage dropped from 10.8 to 10.1 per 100,000 inhabitants (INCA, 2017; Marqués, González, Cruz, 2016; Brasil, 2011).

The highest rates of gastric cancer incidence and mortality occur in East Asia, Central and Eastern Europe, and South America. Mortality rates associated with gastric cancer, even in developed countries, are still very high because of the poor prognosis of this cancer type. Only 28.3% of newly diagnosed patients survive for more than five years after diagnosis (Marqués, González, Cruz, 2016).

Despite some follow-up losses, such as excluding prior adjuvant treatment and cases in children, the estimated costs presented here may be reliable for the care of the disease. From a SUS perspective, the estimates costs provide elements for the management of the service and for studies that result in more rational forms of resource allocation.

In this way, the estimates refer to the voltage for operations with exchange rates of the State of Goiás, mainly due to high frequency and profit rates in the Brazilian region. Thus, it is crucial to evaluate pediatric expenditures that we did not address in this study.

CONCLUSIONS

The analysis proposed in this study allowed us to evaluate the general panorama of expenditures expended by the State Health Department in Goiás on hospitalizations and treatment of gastric cancer under the SUS between 2007 and 2016. The analysis provided information on the magnitude of the cancer problems for public health. We verified that there was an increase in the expenses for hospitalization, treatment, and the number of deaths, with a predominance of male cases. The most substantial treatment expense occurred in 2009. In contrast, the most significant expenditures from hospitalizations occurred in 2014, 2015, and 2016. The results confirm the importance of treatment and hospitalizations as the main cost components of treatment.

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