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The impact of COPD on the private healthcare system in Brazil: an economic analysis

Impacto da DPOC no sistema de saúde privado no Brasil: uma análise econômica

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chronic obstructive pulmonary disease, exacerbation, costs and cost analysis, supplemental health

ABSTRACT

Objective: To assess healthcare resource utilization and hospitalization costs of patients with chronic obstructive pulmonary disease (COPD) exacerbations in the Brazilian private healthcare system. **Methods:** A retrospective cohort study, considering data from an administrative database of a private company (Orizon). Patients aged ≥40 years old and with at least one COPD-related claim identified by the ICD-10 code (J40 to J44) at any time during the eligibility period (January/2010 to December/2013) were included in the analysis. Follow-up was performed until December/2014, death or inactivation of a health plan. Sociodemographic characteristics, number of emergency visits, hospital admissions (number and length of stay), length of hospital stay in an intensive care unit (ICU), number of severe COPD exacerbations, therapeutic approach, and hospitalization costs were assessed. **Results:** The analysis included 8,254 COPD patients. Emergency visits, hospital admission, and exacerbation rates were 0.4, 0.2, and 0.1 per person-year, respectively. The mean length of hospital stays and the length of stay of patients requiring or not ICU stay were 16.6 (SD = 77.0), 8.7 (SD = 36.9), and 27.6 (SD = 109.7), respectively. Mean costs associated to emergency department visits and hospitalizations were 258.2 BRL (SD = 383.1) and 38,165.4 BRL (SD = 124,683.5), respectively. Hospitalizations costs without ICU stay were 11,810.1 BRL (SD = 31,144.1) and 74,585.3 BRL (SD = 182,808.1) for those with ICU utilization. **Conclusion:** Costs for COPD management during disease exacerbation are very high and may reach almost 75 thousand BRL per hospitalization. The prevention of COPD exacerbations and better disease control may reduce the economic burden on the private healthcare system in Brazil.

Palavras-chave:
doença pulmonar obstrutiva crônica, exacerbação, custos e análise de custo, saúde suplementar

RESUMO

Objetivo: Avaliar a utilização de recursos e custos de pacientes com exacerbação da doença pulmonar obstrutiva crônica (DPOC) no sistema de saúde suplementar (SSS) do Brasil. **Métodos:** Estudo de coorte retrospectiva, considerando banco de dados administrativo de uma empresa privada (Orizon). Pacientes com ≥40 anos e pelo menos um registro de admissão relacionado à DPOC identificado com CID-10 J40-J44, entre janeiro/2010 e dezembro/2013, foram incluídos e acompanhados

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Disclosure
Oliver Augusto Nascimento, Mariana Rodrigues Gazzotti, Franco Chies Martins, Felipe Moraes dos Santos[b], Luciana Tarbes Mattana Saturnino[a], Danielle Oliveira da Silva[b], Karynna Pimentel Viana, Rafael Alfonso-Cristancho, Claudia Soares Rodrigues are GSK employees and shareholder."
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até dezembro/2014, morte ou inativação no plano. Características sociodemográficas, número de visitas de emergência, admissões hospitalares (número e tempo de hospitalização), tempo de hospitalização em unidade de terapia intensiva (UTI), número de exacerbações graves, estratégias terapêuticas e custos hospitalares foram as variáveis analisadas. **Resultados:** A análise incluiu 8.254 pacientes com DPOC. As taxas de visita à emergência, internação hospitalar e exacerbação da doença foram de 0,4, 0,2 e 0,1 por pessoa-ano, respectivamente. Os tempos médios de hospitalização, hospitalização sem utilização de UTI e hospitalização com necessidade de UTI foram de 16,6 (DP = 77,0), 8,7 (DP = 36,9) e 27,6 (DP = 109,7) dias, respectivamente. Os custos médios relacionados à visita de emergência e por hospitalização foram de 258,2 BRL (DP = 383,1) e 38.165,4 BRL (DP = 124.683,5), respectivamente. Os custos para pacientes que não utilizaram UTI foram de 11.810,1 BRL (DP = 31.144,1) e de 74.585,3 BRL (DP = 182.808,1) para aqueles com necessidade desse serviço. **Conclusão:** Os custos para o manejo dos pacientes com exacerbação da DPOC são muito elevados, podendo chegar a 75.000 BRL por hospitalização. A prevenção de exacerbações e o melhor controle da doença podem reduzir esse impacto econômico no SSS.

Introduction

The obstruction of pulmonary airflow characterizes chronic obstructive pulmonary disease (COPD). It results in breathing interference and persistent respiratory symptoms (Global Initiative for Chronic Obstructive Lung Disease (GOLD), 2019; Global Initiative for Chronic Obstructive Lung Disease (GOLD), 2020; World Health Organization (WHO), n.d.). The lung's inflammatory response is triggered by inhaling harmful particles or toxic gases. Tobacco smoke represents the main factor, but occupational exposure and biomass combustion are also considered relevant to developing this inflammatory process (Global Initiative for Chronic Obstructive Lung Disease (GOLD), 2018; Ministério da Saúde (Brazil), 2013; Oca *et al.*, 2016). The disease's clinical manifestations may include progressive and chronic dyspnea, cough, sputum production, wheezing, and chronic expectoration (Global Initiative for Chronic Obstructive Lung Disease (GOLD), 2018; Ministério da Saúde (Brazil), 2013).

Worldwide, in 2017 about 300 million people were affected by the disease, and 3.2 million COPD-related deaths occurred (James *et al.*, 2018; Roth *et al.*, 2018). The global prevalence among people over 30 years old in 2010 was 10.7% (Adeloye *et al.*, 2015). In Brazil, COPD represented the fifth leading cause of death from 2007 to 2014 and the fourth from 2015-2016 (Gonçalves-Macedo *et al.*, 2019). A study in São Paulo estimated a 15.8% prevalence among individuals over 40 years old. A marked underdiagnosis and under-treatment of the disease are also reported (Nascimento *et al.*, 2007).

COPD represents the leading cause of hospitalization and requires emergency visits among all causes in the United States, providing a large amount of resource utilization (Murphy *et al.*, 2017). Societal annual costs per patient attributed to COPD management ranges from 1,721 American Dollars (USD) in Russia to 30,826 USD in the United States, considering the years 2012-2013. Data from Brazil shows an estimated 3,824 USD per year (2012-2013) per patient, also considering the societal perspective (Foo *et al.*, 2016). Another analysis from the USA has shown that the direct annual cost per patient may reach 10,812 USD, depending on disease severity (Guarascio *et al.*, 2013).

The most frequent drivers are direct costs, hospitalizations, home oxygen therapy, general practitioner or specialist visits, and drug-related expenditures (Foo *et al.*, 2016). In several countries, hospitalization is the most significant contributor to direct costs ranging from 9% to 63% of the total amount (Foo *et al.*, 2016; Guarascio *et al.*, 2013). In Brazil, COPD represented the fifth major hospitalization cause among individuals aged ≥40 years in the public health setting, with 200,000 episodes and 72 million Brazilian Real (BRL) expended from 2003 to 2013 (Ministério da Saúde (Brazil), 2013).

Healthcare in Brazil is provided by two main components, the public system through the Brazilian Unified Health System (SUS) and the private care represented by the Supplementary Healthcare System (SHS) (Paim *et al.*, 2008). The SHS covers about 25% of the total population, representing approximately 47 million individuals assisted (Agência Nacional de Saúde Suplementar, 2019). Although the considerable assistance provided by the SHS, little is known about COPD management from this perspective.

Given the high healthcare resource utilization observed among COPD patients, understanding the disease impact is essential to improve the economic burden and planning. This study aimed to assess healthcare resource utilization and costs of patients with COPD in the Brazilian SHS, focusing on emergency and hospitalization data.

Methods

It is a retrospective cohort study that considers data from an administrative database of a private company (Orizon). Orizon database covers about 13% of the private market population. All the information obtained from different health insurance companies in Brazil is consolidated in this database. Information regarding COPD patients' transactions was collected directly from the administrative database of medical invoices generated by the Orizon invoicing system. It includes medical invoices for hospitalization and medical procedures

(SADT – auxiliary diagnostic and therapeutic services form) sent by hospitals and outpatient care centers. Data were anonymized and compiled without patients' identification by the Orizon before being analyzed to ensure subjects' privacy. Following local laws (Resolution nº 466/2012), proposed methods dispense the analysis by an ethical committee since it uses only anonymized secondary data, with no possibility of identifying patients' personal information in the dataset.

The cohort of interest was selected in the database through COPD ICD-10 codes (J40-J44) recorded on hospital admission, medical appointments at primary, secondary, and tertiary care with associated procedures performed or not at a physician visit (*e.g.*, lab tests), or emergency visits. Patients were ≥40 years old and presented at least one COPD-related claim identified by the ICD-10 code (J40 to J44) in a healthcare environment (health insurance forms of hospitalization or SADT) at any time during the eligibility period (from 1 January 2010 to 31 December 2013). Individuals with any medical invoice with inactive healthcare insurance plan status recorded during the analysis were excluded from the study.

The sample selected for analysis was followed from patients' identification (first identification of COPD ICD-10 code) to December 2014, or death or inactivation in the healthcare insurance plan – whichever occurred first. Sociodemographic characteristics (age, gender, Brazilian region), emergency visits, hospital admission, length of hospital stay due to COPD or COPD-related causes, and severe COPD exacerbation were assessed. Severe COPD exacerbation was defined as hospitalization registered under at least one of the ICD codes: J00-J06, J09-J11, J12-J18, J20-J22, J40-J47, J80, J96. Due to the unchecked cause of the secondary ICD-10, as it is not a mandatory field, these additional codes beyond J40-44 were selected according to a literature review and validated by a clinical practice physician with extensive experience in the Brazilian private healthcare system to avoid missing any COPD-related exacerbation. Severe COPD exacerbation separated by at least ten days one from another was considered different events independent from each other. After this identification, the number of ER visits, hospitalizations, and ICU hospitalizations was evaluated during the follow-up period. The proportion of patients with none, one, or more events during the first year of follow-up was also assessed to understand these patients' exacerbation characteristics.

The total length of stay, resources utilization, and costs was described as a total. Then it was stratified by patients admitted or not to the ICU to evaluate their differences. From the Brazilian private payer perspective, costs were calculated directly from the Orizon billing. It was adjusted to reflect the value of 2014 BRL (last month available at the time of database analysis) by applying the "Broad National Consumer Price Index (IPCA)" for health, issued by the Brazilian Institute of Geography and Statistics. The cost analysis was stratified by drugs, materials, varying fees (medical, physiotherapists, and other healthcare professional fees), procedures/tests, and medical gases.

Categorical variables were described as numbers and percentages, and all analyses were descriptive. Numerical data were expressed as mean and standard deviation. No statistical testing was applied. Follow-up time was calculated as person-years and considered in all analyses using rates. Patients alive at the end of the follow-up period were censored on the last day of follow-up. R Studio and SPSS version 24 were the statistical software used for data analysis.

Results

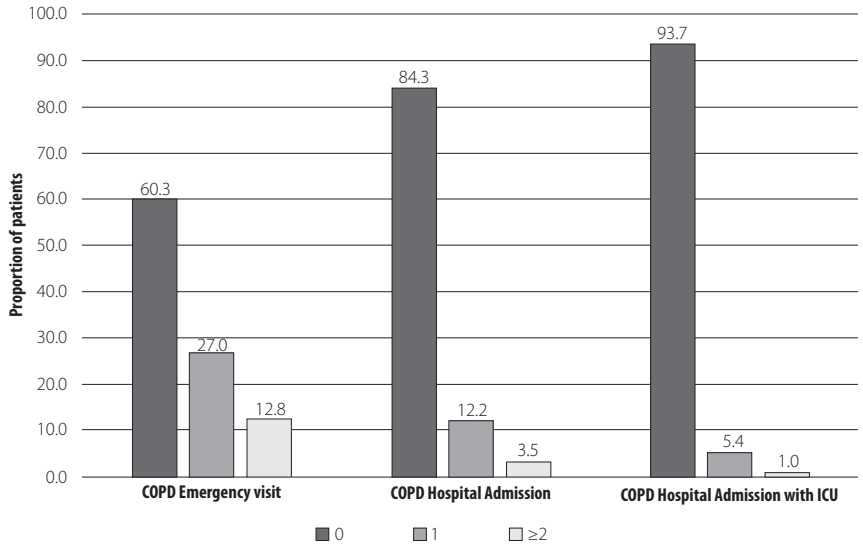
This analysis included a total of 8,254 COPD patients. Most patients were female, from the southeast region, with a mean age of 58.3 years (SD = 13.5). Patients were followed by a mean period of ~2.2 years (808.2 days, SD = 478.9). The most frequent event leading to the first identification in the database was a visit to a physician (54.2%). Table 1 shows the general characteristics of the cohort.

Figure 1 shows the proportion of events observed during the first year of follow-up. In this analysis, most patients had no need for emergency visits (N = 4,054; 60.3%), hospitalization (N = 5,668; 84.3%) and need for ICU stay (N = 6,301; 93.7%). The occurrences of only one emergency visit, hospitalization, and need for ICU stay were observed in 1,835 (27.0%), 820 (12.2%), and 360 (5.3%) patients, respectively. In addition, it is important to note that 12,8% of the COPD patients had two or more visits to Emergency Departments, 15.7% had at least one hospitalization, and 6.4% had at least one admission to the ICU (Figure 1).

Healthcare resource utilization and severe COPD exacerbation rate are shown in Table 2. A severe COPD exacerbation rate of 0.1 per person-year was observed. Considering rates of emergency visits and hospital admissions due to COPD, estimates were 0.4 and 0.2 per person-year, respectively.

A mean total length of 16.6 (SD = 77.0) days was observed for the duration of hospital admission. When the need for ICU stay was considered, different values were observed, with 8.7 (SD = 36.9) and 27.6 (SD = 109.7) days for hospitalizations with or not ICU need, respectively (Table 2).

Table 3 shows emergency and hospitalization-related costs. The mean costs associated with emergency department visits were estimated at 258.2 BRL (SD = 383.1). The main cost driver in emergency visits was the need for medical procedures and tests. The mean hospitalization-related cost per episode was 38,165.4 BRL (SD = 124,683.5). Stratifying costs by the need for ICU stay, mean values were 11,810.1 BRL (SD = 31,144.1), and 74,585.3 BRL (SD = 182,808.1) for hospitalizations with or not ICU need, respectively. Varying fees represented the highest mean cost observed (Table 3).



COPD: chronic obstructive pulmonary disease; ICU: intensive care unit.

Figure 1. Proportion of events observed during the first year of follow-up.

Table 1. General characteristics of the included COPD sample

	Results
Gender – N (%)	
Female	4,170 (50.5)
Age at baseline – Mean (±SD)	58.33 (13.5)
Geographic region of residence – N (%)	
North	55 (0.7)
Northeast	1,170 (14.2)
South	279 (3.4)
Southeast	6,113 (74.1)
Midwest	180 (2.2)
Not reported	457 (5.5)
Follow-up time – Mean (±SD), days	808.19 (478.9)
Event leading to the first identification in the database – N (%)	
Hospitalization	573 (31.6)
Emergency visit	2,611 (6.9)
Physician visit	4,475 (54.2)
Physician visit + admission	595 (7.2)

SD: standard deviation.

Discussion

This study aimed to describe healthcare resource utilization and costs related to COPD management from the Brazilian private healthcare system perspective. It has been shown that most COPD patients have few exacerbations, hospitalizations, and ICU stays. However, healthcare utilization and costs are very high during hospitalization, mainly in patients with ICU admission. In addition, besides the ER visits being less expensive than hospitalizations, they were much more frequent, and almost 40% of the patients went to ER visits in the follow-up period. The study overviews different disease aspects through a large retrospective cohort. Furthermore, data includes knowledge of the economic burden of COPD treatment at hospitalization from the private healthcare perspective.

Table 2. Healthcare resource utilization estimated for the total sample

	Total
Severe COPD exacerbation rate (/1 person-year)	0.1
COPD emergency visit rate (/1 person-year)	0.4
COPD hospital admission (/1 person-year)	
Total	0.2
Requiring ICU stay	0.1
Not requiring ICU stay	0.1
Length of hospital stay (mean, SD)	
Total, days	16.6 (77.0)
Hospital admission not requiring ICU stay (only events not requiring ICU), days	8.7 (36.9)
Hospital admission requiring ICU stay (including time in and out of ICU), days	27.6 (109.7)
Percentage of ICU time in hospital admissions requiring ICU stay, %	67.4 (32.2)

COPD: chronic obstructive pulmonary disease; ICU: intensive care unit; SD: standard deviation.

Table 3. Emergency and hospitalization-related costs per event for the total sample

	Total Mean (SD)
Emergency department visit (Total, BRL)	**258.2 (383.1)**
Drugs	25.9 (254.5)
Materials	40.9 (90.3)
Varying fees	34.2 (60.4)
Procedures and tests	145.7 (160.7)
Medical gases	11.6 (25.9)
Hospitalization not requiring ICU stay (Total, BRL)	**11,810.1 (31,144.1)**
Drugs	3,269.3 (12,183.4)
Materials	1,728.2 (5,036.3)
Varying fees	3,339.5 (18,275.9)
Procedures and tests	2,005.8 (3,820.7)
Medical gases	1,248.1 (2,863.9)
Hospitalization requiring ICU stay (Total, BRL)	**74,585.3 (182,808.1)**
Drugs	18,150.6 (45,979.5)
Materials	14,693.6 (35,958.3)
Varying fees	22,732.7 (78,237.4)
Procedures and tests	9,762.6 (25,753.1)
Medical gases	7,835.8 (26,658.5)
All hospitalizations (requiring or not ICU use, BRL)	**38,165.4 (124,683.5)**
Drugs	9,517.0 (32,049.6)
Materials	7,171.6 (24,458.9)
Varying fees	11,481.5 (53,421.9)
Procedures and tests	5,262.4 (17,361.7)
Medical gases	4,013.8 (17,707.2)

BRL: Brazilian Real; ICU: intensive care unit; SD: standard deviation.

In Brazil, the private healthcare system covers about 25% of the total population, representing approximately 47 million individuals assisted, most of them from the southeast region (about 60%) (Agência Nacional de Saúde Suplementar, 2019). Considering that 74.1% of the analyzed patients were from the southeast region, this sample seems to be representative of the population assisted by SHS.

Regarding healthcare resource utilization, in the first year of follow-up, proportions of patients needing at least one attendance in an emergency room and hospitalization with or not ICU were estimated at 39.8%, 15.7%, and 6.4%, respectively. Despite the low frequency of events observed in this analysis, data reinforces the burden of disease through the high resource utilization and related costs observed.

Gonçalves-Macedo *et al.* (2019) assessed trends in in-hospital morbidity and mortality due to COPD, in Brazil, including hospitalization rates. In this population-based study with a time series from the public healthcare system for the 2000-2016 period, a significant decrease in hospitalizations was reported (Gonçalves-Macedo *et al.*, 2019). Data reported in this study shows that about one-third of COPD patients still need hospital resources at least once a year, even with a decreasing trend reported in the national literature.

Beyond the hospitalization frequency, an important aspect assessed in this study is the length of hospital stay among COPD patients. The analysis has shown 16.6 days as the mean length of hospitalization. This result is very high compared to data from European countries, which showed a mean length of stay of 8.7 (SD = 8.3) days (Ruparel *et al.*, 2016). The time in ICU represented 67.4% of the total time (mean length of stay in ICU: 12.0 days) of those who needed to stay in ICU. Pincelli *et al.* (2011) reported a mean length of stay of 12.0 days in the ICU in a public unit in Santa Catarina, Brazil (Pincelli *et al.*, 2011). However, despite similar results, a decrease in the length of hospital stay was reported, as previously mentioned (Gonçalves-Macedo *et al.*, 2019). These data suggest that further analysis needs to be conducted to understand factors influencing the length of hospital stay among COPD patients.

The need for interventions to improve lung function, like LAMA, is also evidenced in the national literature. Melo *et al.* (2018) evaluated the impact of LAMA inclusion in COPD treatment, and it was reported a significant reduction in both hospitalization rates and costs in states where LAMA is reimbursed versus those without this technology (a difference of 2.5 million BRL from the public healthcare perspective) (Melo *et al.*, 2018). These data highlight that treatment optimization with triple therapy can reduce costs.

Hospital-related costs ranged from 258.2 BRL per emergency visit episode to 74,585.3 BRL per hospitalization with an ICU stay. The need for ICU has also been reported by another study as a cost driver of COPD management, corroborating the data shown in this study (Mulpuru *et al.*, 2017). The main cost drivers were medical procedures and tests in emergency visits and varying fees during hospitalizations. Previous studies in countries such as Vietnam and China indicate drugs as the main cost drivers in COPD hospitalizations (Li *et al.*, 2018; Ngo *et al.*, 2019). Differences in findings may be attributed to different strategies of variables definition regarding costs. However, drugs were the second highest hospitalization cost, representing 25% of the total mean cost of hospitalization.

An unquestionable association between disease exacerbation, increased health resource utilization and costs, and increased hospitalization is known (Guarascio *et al.*, 2013). An exacerbation episode is defined by worsening respiratory symptoms triggered by respiratory infections, environmental pollution, or even unknown factors. Episodes are marked by increased hyperinflation and gas trapping, with reduced expiratory flow leading to dyspnea increase (Global Initiative for Chronic Obstructive Lung Disease (GOLD), 2020). A severe COPD exacerbation rate of 0.1 per person-year was reported in this analysis. The PLATINO study, which includes data from five Latin American cities in Brazil, Chile, Mexico, Uruguay, and Venezuela, assessed exacerbation rates through patients' self-reported information. The occurrence rate of any exacerbation episode was estimated at 0.6 per person-year, and while episodes requiring hospitalization were evaluated, an occurrence of 0.05 per person-year was reported (Montes de Oca *et al.*, 2009). The severe exacerbation rate reported in this study only considers those requiring hospitalization; thus, data is consistent with that observed in other countries.

Garske *et al.* (2018) conducted a study to estimate the cost of moderate/severe COPD exacerbation (which required medical/in-hospital assistance) in patients followed in a Brazilian public pulmonary rehabilitation program. The study reports the total cost in two months reached 7,030.8 BRL from the healthcare system perspective. Patients with a more significant follow-up period in the rehabilitation program showed a lower frequency of exacerbation episodes and costs (Dressler *et al.*, 2018). These data reinforce the importance of strategies to improve lung function for COPD patients and ultimately reduce exacerbation episodes that lead to healthcare resource utilization, such as emergency visits and hospitalization.

In this analysis, only direct costs related to hospitalization events were reported. However, COPD can lead to other impacts, especially indirect costs (Britton, 2003; Kirsch *et al.*, 2019; Lisspers *et al.*, 2018; Piperno *et al.*, 2003; Souliotis *et al.*, 2017). In general, indirect costs account for about 40% of total costs. However, it could represent the main cost driver of financial burden among individuals of working age (45 to 65 years old) (Lisspers *et al.*, 2018; Souliotis *et al.*, 2017). Poor disease control was associated with an increase in indirect burden in a study conducted in German. Patients of working age with the highest disease stages have shown twice as high chances of prematurely retiring, and the number of sick

days increased by over 50% with disease severity (Kirsch *et al.*, 2019). Thus, it is possible to conclude that the COPD burden is still more significant than that reported in this study.

This study adds important information on the COPD burden in Brazil. However, some limitations need to be highlighted. The source of information, a secondary database, depends on the recording quality, which may impose some biased data. Furthermore, recording on a database depends on the information flow from hospitals and outpatient care centers, allowing missed data from different institutions. Additionally, the database did not have secondary cause information data since it is a non-mandatory field. To avoid not capturing COPD exacerbations recorded under other ICD-10 codes, we also considered other respiratory causes as COPD-related exacerbations, based on literature review and expert opinion. That may lead to false positive events being included and a sensitivity analysis not performed. However, the probability of them being associated with a COPD exacerbation is high due to its nature. Furthermore, this strategy is required since it translates the payer's view on the disease.

Conclusion

Management of COPD generates costs that may reach almost 75 thousand BRL per event requiring ICU admission, considering the Brazilian private healthcare system perspective. Despite considering only direct costs, our finding highlights that uncontrolled disease leads to cost increases, mainly driven by the need for hospital assistance.

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