

# Epidemiology and Estimated Cost of Surgeries for Carpal Tunnel Syndrome Conducted by the Unified Health System in Brazil (2008–2016)

## *Epidemiologia e estimativa de custo das cirurgias para síndrome do túnel do carpo realizadas pelo Sistema Único de Saúde no Brasil (2008–2016)*

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### Abstract

**Objective** To define the epidemiological aspects and estimated costs of surgeries performed by the Brazilian Unified Health System (SUS, in the Portuguese acronym) for the treatment of carpal tunnel syndrome (CTS) in Brazil between 2008 and 2016.

**Materials and Methods** Documentary study, with data from the Informatics Department of the SUS (DATASUS, in the Portuguese acronym), about the absolute number and incidence of admissions, the total and mean length of stay (in days), the total expenses, and the hospital and professional services expenses in the surgical treatment of CTS.

**Results** During the period studied, there were 82,123 hospitalizations for surgery, with a 62% increase from 2008 to 2015, accompanied by an increase in the values of professional services. The incidence and the absolute number of procedures were higher in the South and Southeast regions. The North region presented the lowest expenses, absolute number, and incidence of admissions, as well as the longer mean length of stay. The mean length of stay decreased from 1.2 days in 2008 to 0.7 day in 2016. The expenses totaled BRL 29,463,148.80 during the period studied. After 2011, professional services became the largest portion of the total expenses. Hospital expenses corresponded to 52.49% of the expenditure in 2008, and to 36.24% in 2015, while professional expenses received the largest investment compared with the total amount expended in 2012.

### Keywords

- ▶ epidemiology
- ▶ carpal tunnel syndrome/surgery
- ▶ median nerve
- ▶ health expenditures

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**Conclusion** The present study was not consistent with the international literature regarding epidemiological data and cost estimates. Brazil presented a disparity between absolute numbers and annual incidence of admissions and length of stay. Future researches can assess variables that have influenced these results, as well as contribute to public interventions aimed at the improvement of health care.

## Resumo

**Objetivo** Definir aspectos epidemiológicos e estimativas de custos decorrentes das cirurgias realizadas pelo Sistema Único de Saúde (SUS) para tratamento da síndrome do túnel do carpo no Brasil, entre 2008 e 2016.

**Materiais e Métodos** Estudo documental, com dados do Departamento de Informática do SUS (DATASUS), referentes ao número absoluto e à incidência de internações, dias totais e média de permanência nosocomial, valor total investido, e valor dos serviços hospitalares e profissionais no tratamento cirúrgico da síndrome.

**Resultados** No período estudado, realizaram-se 82.123 internações para cirurgia, com crescimento de 62% de 2008 a 2015, acompanhado de incremento no pagamento aos profissionais. A incidência e o número absoluto de procedimentos sobressaíram-se no Sul e Sudeste, invariavelmente. A região Norte apresentou número absoluto, incidência e valor investido menores, além do maior tempo médio de internação. A permanência hospitalar média reduziu-se de 1,2 dias em 2008 para 0,7 dia em 2016. Aplicaram-se R\$ 29.463.148,80 no período. Após 2011, o valor do serviço profissional se tornou a maior parcela do total. A remuneração hospitalar correspondeu a 52,49% do gasto em 2008 e a 36,24% em 2015, enquanto o gasto com profissionais recebeu o maior investimento em relação ao total de despesas em 2012.

**Conclusão** O presente estudo foi discrepante da literatura internacional no que concerne a dados epidemiológicos e estimativas de custo. No Brasil, notou-se disparidade entre o número absoluto, a incidência anual e o tempo de internação hospitalar desses pacientes. Pesquisas futuras poderão avaliar as variáveis que influenciaram estes resultados, bem como contribuir para intervenções públicas que visem à melhoria da assistência.

## Palavras-chave

- ▶ epidemiologia
- ▶ síndrome do túnel do carpo/cirurgia
- ▶ nervo mediano
- ▶ gastos em saúde

## Introduction

Carpal tunnel syndrome (CTS) is the most common compressive mononeuropathy, and it is characterized by the compression of the median nerve at the level of the wrist.<sup>1-5</sup>

The first description of CTS is attributed to Paget, who reported a case of compression of the median nerve resulting from a distal radius fracture.<sup>6</sup>

The carpal tunnel is an inextensible osteofibrous tunnel defined as the space between the flexor retinaculum (FR), which constitutes the roof, and the carpal canal, which constitutes the fundus. It is delimited at the ulnar border by the hook of the hamate and by the pyramidal and pisiform muscles, and at the radial border by the scaphoid, the trapezium, and the flexor retinaculum muscles. The base is formed by the capsule, and the anterior radiocarpal ligaments cover underlying portions of the scaphoid, the lunate, the capitate, the hamate, the trapezium, and the trapezoid muscles. The median nerve, in turn, is accompanied by the four tendons of the flexor digitorum superficialis (FDS), by the four tendons of the deep flexor muscles of the fingers (FPD), and by the tendon of the flexor longus muscle of the thumb (FPL). The FPL is the most radial element. At the entrance of the tunnel, the median

nerve is dorsal to the tendon of the palmaris longus muscle (PL), between the tendons of the Flexor Carpi Radialis (FCR) and the flexor digitorum superficialis (FDS). In the distal part of the tunnel, the median nerve divides into the following branches: lateral, medial, and recurrent thenar; the former two branches subdivide further. The thenar branch passes through a separate tunnel before reaching the thenar muscles in 56% of the cases.<sup>7</sup>

Typical CTS symptomatology is manifested by pain, hypoesthesia, and paresthesia in the sensory innervation territory of the median nerve and, in some cases, paresis for thumb opposition and abduction, as well as signs of thenar atrophy.<sup>8</sup> The risk factors for CTS include diabetes mellitus, alcoholism, amyloidosis, rheumatoid arthritis, infectious synovitis, gout, dermatomyositis, scleroderma, hypothyroidism, long-term hemodialysis, obesity, repeated flexion-extension wrist movements, extended wrist use to move loads, and wrist trauma.<sup>9</sup>

The differential diagnosis should include C6 and C7 vertebrae radiculopathy, proximal medial nerve compressions in the arm (Struthers ligament) or in the forearm (pronator syndrome), and double impact syndrome. Less frequently, upper motor neuron

disease, cervical intraradicular injuries, neuropathies, and syringomyelia can be considered in the differential diagnosis.<sup>8</sup> Although an obvious cause for CTS is not identified, most cases are well-related to heavy manual labor.<sup>10</sup>

The treatment for CTS can be conservative or surgical. Surgery is indicated in cases with electrophysiological evidence of median nerve denervation; acute post-traumatic cases associated with significant local edema; significant functional impairment of the median nerve, evidenced by thenar atrophy and/or severe motor and sensorial changes; conservative treatment failure; or complying with the choice of the patient.<sup>11,12</sup> The frequency of indication for surgical treatment is high, ranging from ~31 to 40% of the diagnosed patients; it is estimated that US\$ 2 billion are spent annually in the United States on the surgical treatment of CTS.<sup>13,14</sup>

The surgical technique for the treatment of CTS underwent great advances. Open surgery results in a bigger surgical scar, increasing the recovery time and the risk of complications. Modern strategies consist of endoscopic and mini-incision methods, which reduce the length of stay, complications, and scarring, resulting in an early return to work.<sup>13</sup> A major limitation of the new techniques, especially the endoscopic technique, is the need for larger hospital equipment, often requiring expensive disposable items, which is not a reality in low-budget regions. Another caveat is the need for endoscopic training, which increases the time required for a proper learning curve. The mini-incision technique tries to combine the lower expense of the open surgeries with the shorter length of stay and reduced scarring of the endoscopic method; however, further studies are needed for its long-term assessment.<sup>15,16</sup>

Given the socioeconomic impact (up to US\$ 30,000 in the lifetime of each United States worker) of this pathology and the best results obtained with surgical treatment (superiority in functional improvement, in addition to early and long-term regression of the symptoms),<sup>17</sup> the present study tried to define the epidemiological aspects and cost estimates resulting from surgeries performed by the Brazilian Unified Health System (SUS, in the Portuguese acronym) for the treatment of CTS in Brazil between 2008 and 2016.

## Materials and Methods

This is a documentary study. Queries in the information system from the Informatics Department of the SUS (DATA-SUS, in the Portuguese acronym) yielded national and regional registries regarding the surgical treatment of CTS from January 2008 to July 2016. The study population corresponds to people submitted to treatment with the procedural code 0403020123 (surgical treatment of compressive syndrome in osteofibrous tunnel at the carpal level).

The variables studied were the absolute number and the annual incidence of hospital admission, the total and mean length of stay (in days), total expenses, and hospital and professional services expenses.

For the proper interpretation of the results, data on population variation over the years was also obtained, using the 2010 demographic census and estimates by the Brazilian

Institute of Geography and Statistics (IBGE, in the Portuguese acronym).

The results were tabulated using the Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) software and were subsequently analyzed.

Next, a bibliographic survey was conducted, searching for Brazilian and international publications in the PubMed, Virtual Health Library (BVS, in the Portuguese acronym), Latin American and Caribbean in Health Sciences (LILACS), National Library of Medicine (MEDLINE), and Scientific Electronic Library Online (SciELO) databases with the following descriptors: *epidemiology*, *carpal tunnel syndrome*, *median nerve* and *costs*. To narrow the search, only articles published from 1998 to 2016 were considered. The following inclusion criteria were used: papers published in indexed national and international journals, written in English and Portuguese. Papers with titles and abstracts that did not fit the research objectives were excluded.

## Results

From January 2008 to July 2016, there were 82,123 hospitalizations for the surgical treatment of CTS at the SUS. From this total, 14.18% were performed in 2014, the year with the highest number of procedures. In all of the years analyzed, the Southeast region presented the highest rates, while the North region remained with the lowest rates (►Table 1).

The highest and lowest counts per region occurred in the Southeast region in 2014 and in the North region in 2010, with 5,911 and 72 hospitalizations for surgery, respectively. There was a growth of 62%, rising from 6,830 in 2008 to 11,078 in 2015. All of the regions presented an increasing pattern, except the North region, with oscillation over the years, and the Northeast region, with an initial decrease associated with a discrete growth in 2014 and a sudden peak in 2015 (1,072 procedures).

The annual incidence of hospitalizations for the procedure increased 50.27%, with its apex in 2014, when it reached a rate of 5.46 per 100,000 Brazilian inhabitants. The highest regional incidence was recorded in the South region in 2014 (12.32), and the lowest in the North region in 2010 (0.43). These regions accounted for, respectively, the highest and lowest admission numbers in all of the years studied. The North and Northeast regions were the only ones presenting a decrease in the incidence in the comparison between 2008 and 2015. Like the admission incidence, the growth rate was higher in the South and Central-West regions, and lower in the North and Northeast regions (►Table 2).

The total hospitalization time for the surgical treatment of CTS declined nationally over the years (►Table 3). Considering the fully reported period (2008–2015), the greatest length of stay occurred in 2008, with 8,520 days, and the lowest occurred in 2015, with 8,177 days. Following the national trend, this absolute value fell in the North, Northeast and Southeast regions; however, it grew significantly in the South and Central-West regions. The mean length of stay in Brazil fell from 1.2 to 0.7 day in 2015. It was higher in the North region in all of the years studied, and lower in the

**Table 1** Number of hospital admissions for the surgical treatment of carpal tunnel syndrome at the SUS by region, 2008–2016

Year	Number of procedures	North region	Northeast region	Southeast region	South region	Central-West region
2008	6,830	113	1,027	3,858	1,411	421
2009	7,920	74	927	4,306	2,082	531
2010	8,577	72	919	4,865	2,128	593
2011	10,030	109	864	5,673	2,695	689
2012	10,097	143	882	5,225	3,045	802
2013	10,166	132	833	5,054	3,237	910
2014	11,646	155	844	5,911	3,576	1,160
2015	11,078	118	1,072	5,807	3,082	999
2016*	5,779	74	680	3,010	1,457	558
Total	82,123	990	8,048	43,709	22,713	6,663

Abbreviations: SUS, Brazilian Unified Health System.

Source: DATASUS, 2016. \*Reports from the first 7 months of 2016.

**Table 2** Annual incidence of surgical treatment of carpal tunnel syndrome at the SUS by region per 100,000 inhabitants, 2008–2015

Year	Annual incidence	North region	Northeast region	Southeast region	South region	Central-West region
2008	3.60	0.74	1.93	4.81	5.13	3.07
2009	4.13	0.48	1.72	5.32	7.51	3.82
2010	4.49	0.43	1.73	6.05	7.77	4.22
2011	5.21	0.67	1.61	7.00	9.77	4.83
2012	5.20	0.87	1.63	6.40	10.97	5.56
2013	5.05	0.77	1.49	5.98	11.24	6.06
2014	5.46	0.89	1.50	6.94	12.32	7.62
2015	5.41	0.67	1.89	6.77	10.54	6.46

Abbreviations: SUS, Brazilian Unified Health System.

Source: DATASUS, 2016. Incidence determined from population data provided by IBGE. Data from 2016 was not included due to possible seasonal incidence variations not analyzed in the present work.

**Table 3** Total length of stay (in days) of carpal tunnel syndrome patients surgically treated at the SUS per region, 2008–2016

Year	Total days	North region	Northeast region	Southeast region	South region	Central-West region
2008	8,520	277	1,620	4,215	1,415	993
2009	7,801	138	1,414	3,858	1,639	752
2010	7,930	198	1,343	4,020	1,524	845
2011	8,321	203	1,222	4,148	1,761	987
2012	8,410	243	1,233	3,654	2,120	1,160
2013	8,370	321	1,134	3,406	2,218	1,291
2014	9,105	245	1,154	3,706	2,347	1,653
2015	8,117	247	1,382	3,073	1,993	1,422
2016*	3,865	85	697	1,419	902	762

Abbreviations: SUS, Brazilian Unified Health System.

Source: DATASUS, 2016. \*Reports from the first 7 months of 2016.

South and Southeast regions, which presented the lowest mean lengths of stay in all of the periods studied. The Southeast region had the lowest rate of 2016 (0.5). The highest mean value was recorded in 2010, in the North region, reaching 2.8 days (►Table 4). Regarding the total

procedural expenditure, ►Table 5 shows that the largest value occurred in 2014, when it reached BRL 4,957,966.85, decreasing to BRL 4,632,777.69 in 2015. This cost is higher than those observed in 2013 and in the previous years. The only year in which there was a cost reduction compared with

**Table 4** Mean length of stay of carpal tunnel syndrome patients surgically treated at the SUS per region, 2008–2016

Year	Mean period (days)	North region	Northeast region	Southeast region	South region	Central-West region
2008	1.2	2.5	1.6	1.1	1.0	2.4
2009	1.0	1.9	1.5	0.9	0.8	1.4
2010	0.9	2.8	1.5	0.8	0.7	1.4
2011	0.8	1.9	1.4	0.7	0.7	1.4
2012	0.8	1.7	1.4	0.7	0.7	1.4
2013	0.8	2.4	1.4	0.7	0.7	1.4
2014	0.8	1.6	1.4	0.6	0.7	1.4
2015	0.7	2.1	1.3	0.5	0.6	1.4
2016*	0.7	1.6	1.1	0.5	0.6	1.4

Abbreviations: SUS, Brazilian Unified Health System.

Source: DATASUS, 2016. \*Reports from the first 7 months of 2016.

**Table 5** Total expenditure (in BRL) of the surgical treatment of carpal tunnel syndrome at the SUS per region, 2008–2016

Year	Total (BRL)	North region	Northeast region	Southeast region	South region	Central-West region
2008	1,956,232.97	32,450.94	293,199.53	1,104,713.59	399,028.41	126,840.50
2009	2,264,984.46	25,316.52	267,189.58	1,229,803.11	631,633.43	152,351.28
2010	2,505,128.36	22,727.17	274,414.41	1,419,187.76	614,466.80	174,332.22
2011	3,330,652.34	36,400.55	296,005.01	1,874,866.80	894,129.29	229,250.69
2012	3,621,110.85	51,397.39	318,348.32	1,859,957.38	1,082,463.07	308,945.08
2013	4,060,832.58	49,872.47	304,416.70	1,872,309.66	1,409,867.96	424,365.79
2014	4,957,966.85	55,386.46	310,609.16	2,453,460.40	1,600,756.42	537,709.41
2015	4,632,777.69	44,931.42	392,388.76	2,387,386.78	1,355,372.79	452,598.94
2016*	2,133,462.70	26,194.35	260,334.74	1,076,805.11	516,313.48	253,815.02

Abbreviations: SUS, Brazilian Unified Health System.

Source: DATASUS, 2016. \*Reports from the first 7 months of 2016.

the previous one was 2015. Over 8 years and 7 months, the expenses totaled BRL 29,463,148.80. Analyzing the entire period studied, the highest expense occurred in the Southeast region, reaching BRL 2,453,460.40 in 2014, equivalent to ~ 49.5% of the national expenditure of that year. There was a 136.8% increase in investment from 2008 to 2015 throughout Brazil. Throughout the years, the Southeast region was superior to the others in terms of applied capital. The Northeast, South and Central-West regions showed a clear investment growth, while the North region, despite modest variations, always maintained the lowest total expenditure, reaching a maximum of BRL 55,386.46 in 2014.

The hospital services expenses, which are components of the total expenditure, oscillated in a similar way over the years, with a maximum expense in 2014 (► **Table 6**). The hospital services expenses accounted for 52.49% of the total invested in 2008, falling progressively to 35.7% in 2014, increasing to 36.24% in 2015, and to 40.58% in the first 7 months of 2016. These proportions have maintained the same percentages in all of the regions in 2008 and in 2015.

The highest amount paid for professional services was in 2014 (BRL 2,373,272.41), which corresponds to 47.5% of the total expenditure in 2008, and it reached a maximum

proportion of 56.77% in 2012. The professional service expenses fell progressively to 47.86% in 2014. In the first 7 months of 2016, this proportion was of 54.52%, indicating a new rise that started in 2015 (48.74%) (► **Table 7**).

## Discussion

Although CTS is the most common neuropathy of the upper limb and its surgery is usually performed by neurosurgeons and orthopedists, it is a condition with few epidemiological data in Brazil and other countries. Data from international studies show a relevant divergence regarding the annual incidence of CTS. A study performed in the Netherlands in 2001 showed an annual incidence of 1.8 per 1,000 inhabitants, predominantly in female patients aged between 45 and 64 years old. In Siena, Italy, from 1991 to 1998, the incidence of CTS was of 329.4 per 100,000 people. In the United Kingdom, a study performed from 1992 to 2001 showed an annual incidence of 139.4 for women and of 67.2 for men per 100,000 inhabitants in the city of Canterbury, and of 83.2 for women and of 48 for men per 100,000 cases in Huddersfield; all of the cases were confirmed by electrophysiological tests. In 2008, 127,268 patients ≥

**Table 6** Total amount (in BRL) paid for hospital services related to the surgical treatment of carpal tunnel syndrome at the SUS per region, 2008–2016

Year	Total (BRL)	North region	Northeast region	Southeast region	South region	Central-West region
2008	1,027,020.31	17,085.56	154,185.39	578,351.61	208,226.80	69,170.95
2009	1,188,365.60	14,709.68	141,461.27	643,205.75	308,421.35	80,567.55
2010	1,283,200.64	12,135.40	142,844.11	724,654.98	312,903.75	90,662.10
2011	1,508,050.76	16,842.17	135,945.82	847,939.35	400,306.52	107,016.90
2012	1,520,242.30	22,291.00	136,633.74	778,419.56	458,155.97	124,742.03
2013	1,545,954.63	22,560.91	130,193.12	753,333.04	497,924.79	141,942.77
2014	1,770,406.62	23,879.47	130,987.62	886,127.41	550,382.92	179,029.75
2015	1,679,020.01	19,058.65	165,658.33	869,743.15	470,898.48	153,661.40
2016*	865,848.20	11,400.75	105,293.13	446,178.44	220,892.10	82,083.78

Source: DATASUS 2016. \*Reports from the first 7 months of 2016.

**Table 7** Total amount (in Brazilian reais) paid for professional services related to the surgical treatment of carpal tunnel syndrome at the SUS per region, 2008–2016

Year	Total (BRL)	North region	Northeast region	Southeast region	South region	Central-West region
2008	929,212.66	15,365.38	139,014.14	526,361.98	190,801.61	57,669.55
2009	1,076,618.86	10,606.84	125,728.31	586,597.36	281,902.62	71,783.73
2010	1,221,927.72	10,591.47	131,570.30	694,532.78	301,563.05	83,670.12
2011	1,822,601.58	19,558.38	160,059.19	1,026,927.45	493,822.77	122,233.79
2012	2,055,957.32	29,106.39	181,714.19	1,065,604.56	617,055.38	161,476.80
2013	2,072,507.25	26,963.94	171,964.05	1,033,671.66	655,507.26	184,497.34
2014	2,373,272.41	31,506.99	172,843.50	1,209,616.92	724,318.67	234,977.33
2015	2,258,446.24	24,134.67	220,473.71	1,186,946.83	624,363.27	202,527.76
2016*	1,163,347.14	14,793.60	138,686.31	611,092.48	289,091.68	108,681.07

Abbreviations: SUS, Brazilian Unified Health System.

Source: DATASUS 2016. \*Reports from the first 7 months of 2016.

20 years old underwent surgery in metropolitan France, with an incidence of 2.7 surgeries per 1,000 inhabitants.<sup>1–5</sup> In a study conducted in the eastern part of the county of Kent in the United Kingdom, from 1992 to 2001, 6,245 patients were diagnosed with CTS by an electroneuromyography test, and, of these, 4,646 underwent surgical treatment, resulting in an incidence of 349 procedures per 100,000 inhabitants, considering the entire regional population in 2001.<sup>4,18</sup> It is estimated that 400 thousand surgeries for CTS correction will be performed annually in the United States, equivalent to an incidence of 125 surgeries per 100,000 inhabitants, considering the population of the country in 2014.<sup>17,19</sup>

There was a total of 82,123 hospitalizations for surgery throughout the period studied in all of the Brazilian territory, with a 62% increase in the number of procedures from 2008 to 2015. The incidence of surgical treatment for CTS varied similarly to the total surgeries rate: from 3.6 per 100,000 people in 2008 to 5.41 per 100,000 people in 2015, equivalent to a 50.27% growth.

The analysis of the aforementioned data reveals that the Brazilian incidence of the surgical treatment for CTS is significantly lower than those observed in developed countries. This

discrepancy could have different explanations: a result of the precarious investment in the public health system; technical difficulties for the health care professionals; lack of reference services; SUS inefficiency, resulting in long waiting periods for the procedures to be performed; preference of the patients for the private system, as well as the noncomputation of the data coming from the private system.

The highest absolute number of hospitalizations was observed in the Southeast region, with a total of 43,709, which represents 52% of the national number. The same cannot be said of the incidence of hospitalizations, which is higher in the South region, with ~ 10.54 per 100,000 inhabitants in 2015. In contrast, the North region had the lowest hospitalization rate, with a total of 8,048, equivalent to 9% of the whole country. It also presents the smallest incidence of surgeries, with ~ 0.67 procedures per 100,000 inhabitants in 2015. It is possible to notice regional variations that can probably be justified by demographic, economic, and social factors; as such, the South and Southeast regions have a higher population density, greater access to high complexity centers, and a greater volume of physicians qualified for the diagnosis and surgical treatment of CTS.

The highest length of stay occurred in 2014, which is consistent with the number of surgeries performed in the period. Nevertheless, the length of stay decreased over the years, which could be associated with the evolution of the surgical technique, the training of the professionals, and with the greater safety for early hospital discharges. Although presenting the highest absolute lengths of stay for CTS treatment, the Southeast and South regions had the lowest mean lengths of stay. On the other hand, the North region, despite having the lowest number of hospitalizations, maintained the highest mean length of stay.

In the period studied, BRL 29,463,148.80 were spent. The highest total national expenditure was registered in 2014, with BRL 4,957,966.85, an 136.8% increase compared with 2008. This fact demonstrates that the increase in the number of surgeries was accompanied by a greater investment in hospitals and health care professionals. It is important to note that, according to the Management System for the Table of Procedures, Medications and Orthoses, Prostheses and Materials (SIGTAP, in the Portuguese acronym) of the SUS, the total expenses per procedure was BRL 280.14 from 2008 to May 2011, when it increased to BRL 347.62, which corresponds to a 24% increase in 3 years. This variation resulted from a 50% increase in the value of professional services (from BRL 134.96 to BRL 202.44 per surgery).

Regarding the cost of the surgical procedure in other countries, it is estimated that open CTS surgery in the province of Ontario, Canada, costs on average CAD 307 per patient. The total cost of Medicare (the health insurance program of the United States for people > 65 years old) was USD 842.<sup>20,21</sup> These data allow us to infer that international investments in the surgical treatment of CTS are superior to the national ones. This can result from a more attractive professional remuneration and from the greater apparatus available for the performance of the procedures.

At the interregional level, the highest expenses occurred in the Southeast region, with a maximum of BRL 2,453,460.40 in 2014, corresponding to 49.5% of the national expenditure in that year. In contrast, the North region always remained with the lowest values throughout the period studied. This can be explained by the lower incidence and by the lower absolute number of surgeries in the North, since the cost per procedure is the same throughout Brazil.

The hospital and professional services expenses make up the total expenditure. Until 2011, the hospital expenses accounted for most of the total cost; then, there was an inversion, a fact justified by the SIGTAP changes already mentioned. As of 2012, the professional and hospital expenses ceased to be the only components of the total expenditure. This can be observed by the incompatibility of the total recorded value in relation to the sum of both services. In 2008, this result was the exact total cost value. The resources not attributed to the 2 services correspond to 1.25% of the total in 2012; 10.91% in 2013; 16.44% in 2014; 15.02% in 2015; and 4.9% in the first 7 months of 2016. As such, there is a 3<sup>rd</sup> variable composing the total expenses as of 2011, but not explained in the information system, perhaps due to a failure in the documentation process.

Despite the reliable data regarding procedures performed by the SUS, the method used in the present study has the bias of not evaluating the patients submitted to clinical treatment, not considering surgeries performed at the private health care network, and the possibility of typing and registration errors. Another bias is the existence of three more codes that can be used by surgeons for the surgical treatment of CTS: peripheral nerve neurolysis (procedural code: 0403020077), peripheral nerve micro-neurolysis (procedural code: 0403020050), and neuropathy with or without microsurgery (procedural code: 0403020115) (→ **Table 8**).

**Table 8** Distribution of the number of procedures with codes used for the surgical treatment of carpal tunnel syndrome patients at the SUS, 2008–2016

Year	Nonfunctional peripheral nerve neurolysis (procedural code: 0403020077)	Peripheral nerve micro-neurolysis (procedural code: 0403020050)	Compressive neuropathy with or without microsurgery (procedural code: 0403020115)	Total
2008	3,123	4,376	5,151	12,650
2009	3,453	5,024	6,015	14,492
2010	3,157	4,874	5,988	14,019
2011	3,049	4,934	6,532	14,515
2012	3,291	5,059	7,139	15,489
2013	3,021	4,821	7,156	14,998
2014	3,134	4,918	7,064	15,116
2015	3,917	6,413	8,508	18,838
2016*	2,267	1,526	2,582	6,375
Total	26,145	40,419	53,553	120,117

Abbreviations: SUS, Brazilian Unified Health System.

Source: DATASUS 2016. \*Reports from the first 7 months of 2016.

## Conclusion

There was an inconsistency between the present study and the international literature regarding epidemiological data and cost estimates for the surgical treatment of CTS. Within the Brazilian territory, there was a disparity between the absolute number of admissions, the annual incidence, and the length of stay of these patients. Expenses with the surgical procedure were lower compared with other studied countries, although Brazilian patients had longer lengths of stay. Over the years, there was a value readjustment, favoring professional services. It is important to emphasize the presence of a noninclusion bias from patients submitted to clinical treatment or who underwent surgeries through the private health care system. Future research can evaluate the variables that influenced the results obtained, as well as, in some way, contribute to public interventions aimed at improving the medical care of these patients.

### Conflicts of Interest

The authors have no conflicts of interest to declare.

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